A prospective study of

"SHORT TERM FUNCTIONAL OUTCOME ANALYSIS FOLLOWING FIXATION FOR FLOATING KNEE INJURIES"

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CERTIFICATE

This is to certify that the dissertation titled, **"SHORT TERM FUNCTIONAL OUTCOME ANALYSIS FOLLOWING FIXATION FOR FLOATING KNEE INJURIES"** is a bonafide original research work carried out by **DR. POORANA RAJA.T**, Post Graduate, Department of Orthopaedics, Govt. Royapettah hospital, Govt. Kilpauk Medical College under our direct supervision and guidance in partial fulfilment of the requirements for the award of the degree of **M.S.Orthopaedic Surgery – Branch II** during the academic year 2012-2015.

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DECLARATION

I, **Dr. POORANA RAJA.T,** hereby solemnly declare that the dissertation entitled **"Short term functional outcome analysis following fixation for Floating knee injuries"** has been conducted by me under the guidance and supervision of **Prof. S. Anbazhagan** in the Govt. Royapettah Hospital, Govt. Kilpauk Medical College.

This dissertation is submitted to The **Tamilnadu Dr. M.G.R Medical University, Chennai** in partial fulfilment of the university rules and regulations for the award of the degree of **M.S. Orthopaedic Surgery – Branch II**

This has not previously been submitted by me for the award of any degree or diploma from any other university.

(Dr. POORANA RAJA .T)

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Introduction

INTRODUCTION

Floating knee injuries are relatively rare and complex injuries. The type of fractures, soft tissue and associated injuries make this a challenging problem to manage[2].

The incidence of fractures resulting from motor vehicle accidents is on the rise. High velocity accidents are now more common producing violent and complex injuries.

Floating knee refers to the flail knee joint segment resulting from a fracture of the shaft or adjacent metaphysis of the ipsilateral femur & tibia. The fracture may be simple diaphyseal to complex intra articular types. This has increased in the proportion to population growth, number of motor vehicles on the road, and high speed traffic.

These multiple fractures add a new dimension to the problem of their management.

In addition to the complex fractures associated with these injuries, trauma to the soft tissues is often extensive. There also may be life threatening injuries to the head, chest or abdomen and a high incidence of fat embolism. Management of these fractures have been variously described in literature .

Floating knee injuries prone to cause permanent disabilities if not managed aggressively. Different methods of surgical treatment are adopted and this influences the outcome.

The methods of surgical management depend on location and pattern of injuries, hemodynamic status of the patient, associated injuries and would need a judicious combination of internal and external fixation methods, often performed in stages. Combination of intramedullary nailing, plating and external fixation are very often required.

Complications associated with the management of these injuries include infection, excessive blood loss, fat embolism, malunion, delayed or non union, knee stiffness, prolonged hospitalisation and difficulty in weight bearing and return to the previous job.

Aim of the study

AIMS AND OBJECTIVES

1) To evaluate 27 cases of floating knee injuries which have been treated with various modalities of treatment as per the fracture pattern.

2) To analyse the short term functional outcome following definitive fixation of these injuries using Karlstrom Olerud criteria.

Review of literature

REVIEW OF LITERATURE

The management of these difficult injuries gradually evolved due to,

1) Better understanding of functional anatomy and biomechanics of the knee, femur and tibia.

2) Identification and treatment of associated injuries.

3) The advent of internal fixation devices.

4) Advancement in other surgical specialities.

5) Aggressive soft tissue management.

In 1975, Blake and McBryde reported a series of forty seven patients[4] .Most of the patients were young men who had multiple injuries due to high velocity trauma and complications associated with these fractures were frequent. Delayed union or non union occurred in 44.6% of the total number of bones involved. **60% to 70% of these patients had significant permanent functional disability**

In 1977 Karlstrom and Olerud reported thirty two patients with floating knee injuries,out of them fourteen were treated with rigid internal or external fixation for both fractures[5]. Three patients were treated with internal or external fixation for one fracture and conservative treatment for the other. Fifteen patients underwent non operative management for both fractures. The patients who were treated operatively for both fractures had a lower complication rate , shorter hospital stay and less time for healing. **An active surgical approach produced considerably better functional end results**. Most of these patients treated surgically, resumed their former occupations compared with the patients treated non-operatively.

In 1978 Fraser reported 222 patients with ipsilateral fractures of the femur and tibia[6]. Patients were grouped according to the type of fracture and treatment methods. **The worst results were in those treated with non operative management of both fractures.** Following this, more use of external fixation and of cast bracing was recommended in the management of the fractured tibia. Internal fixation was advised for the femoral fractures. They also found out that clinical examination of the knee at post operatively and/ or during follow up suggested that disruption of ligaments was a common occurrence and should always be suspected in the presence of recurrent knee instabilities.

In 1979, De Lee reported treatment of floating knee injuries in seventeen patients with cast bracing for both fractures as definitive management[8]. **Shortening and malunion was common with this type of non operative management.**

Later in 1986 Letts et al analyzed fifteen patients with floating knee injuries and classified the injuries into five types according to the location and nature of fractures[1]. Letts classification is favoured because it classifies the nature of injury (closed or open) as well as the anatomical location of fractures. These factors have been shown to influence both the treatment and outcome.

In 1984, Bansal reported 40 patients with floating knee injuries with the follow up of six months to two years[9]. He found that the results were comparatively better in those patients treated by cast bracing or when the fracture of the femur was stabilized internally. In all these patients fractures of tibia were treated nonoperatively. **The final functional result was poor if the femoral fracture was situated in the condylar flare.**

Katada reported fourteen patients with floating knee injuries. He found that ILIM nailing of both femur and tibia gave good results[10]. As communition is often severe in these patients intramedullary nailing with Kuntscher nail may be difficult. He introduced a closed Enders nailing for femoral and tibial shaft fractures. Its advantages were that it was technically simple, has wide indications and results in rapid bone union without knee stiffness.

In 1984, Veith et al reported about fifty seven patients, fifty six of those femoral fractures and half of the tibial fractures were treated with internal fixation[2]. These included open fractures also. He reported that overall good or excellent functional result was achieved in about 80 % of those patients. **The best results were achieved when both fractures were stabilized surgically.**

In 1987 Behr described flexible intramedullary nailing for patients with shaft fractures and achieved good results[11]

In 1996, Gregory described retrograde nailing for the femur and unreamed nailing for the tibia[12].

Lobenhoffer in 1997 described a complex knee joint trauma which includes floating knee injuries with severe soft tissue injury, knee dislocation, vascular and neurological injury[13]. This was treated with soft tissue sparing minimally invasive reduction and fixation techniques to reduce the complication rate. He describes that percutaneous plate fixation, percutaneous screw fixation and hybrid fixation should be used in these patients. In knee dislocations, the central pivot with the two cruciate ligaments should be reconstructed using augmented repair or primary tendon grafting in every patient.

In 2000, Ostrum described percutaneous single incision nailing of femur and tibia[14].

Rethnam in 2006 reported that irrespective of the iatrogenic ligament injury due to the procedure itself, **the single incision nailing for the floating knee injuries produced good results[15] .**

In 1991 Van Raay reported 31% of incidence of ligament injuries in forty seven floating knee injury patients[16]. In view of high incidence of missed ligamentous injuries, the possibility of disruption of the knee ligaments should be considered in all patients with fractures of both femur and tibial shaft. He advised re-examination of the knee joint for ligament disruption after stabilization of femur and tibia. He also described that knee instability was the major cause for poor end results in these patients . The knee joint dislocation and vascular injury were treated with reduction of dislocation, early exploration and repair of blood vessels. The soft tissue injuries were reconstructed with split thickness skin grafting or flap cover.

Ulfin Rethnam, Rajam S. Yesupalan and Rajagopalan Nair[17], 17. did a study on floating knee and its epidemiology, prognostic indicators and outcome following surgical management. This study included 29 patients with floating knee injury. The follow up period was over 3 years. **The study concluded that the associated injuries and the type of fracture are the prognostic indicators in the outcome**. Good final outcome can be obtained by the appropriate management of associated injuries, intramedullary nailing of both femur and tibia and good post operative rehabilitation.

Ostrum RF, did a study on the treatment of floating knee injuries through a single percutaneous approach. The study included 20 patients[14].

The operative procedure included a 4 cm medial parapatellar tendon incision and introduction of a femoral intramedullary nail and a small diameter tibial intramedullary nail through the same incision. It has been concluded that although it is an excellent method for ipsilateral femoral and tibial fractures, but the morbidity and tibial fracture complications are high.

Lundy DW, Johnson KD[18], gave a brief outline on ipsilateral fractures of femur and tibia, the definition of floating knee injuries. The definition is as follows ‘Ipsilateral fractures of femur and tibia and may include combination of diaphyseal, metaphyseal and intraarticular fractures.’ Diaphyseal fractures are better than intraarticular fractures for the outcome.

Theodoratos G, Papanikoloaou A., Apergis E, Maris J, did a study on 54 patients with ipsilateral diaphyseal fractures of femur and tibia[19]. Open injuries - 8 femurs and 24 tibia. Patients were classified as group A, B and C. Group A was treated with intramedullary nailing of femur and tibia. Group B was treated with intramedullary nailing of femur and external fixation of tibia. Group C was treated with external fixation of femur and tibia. More complications were seen in femoral fractures fixed with external fixation . The study concluded that intramedullary nailing is the best choice for femoral fracture and if possible for tibial fractures also except grade IIIB and C open injuries.

Rios JA, Ho-Fung V, Ramirez N, Hernandez RA, did a study on floating knee injuries treated with single incision technique versus traditional ante grade femur fixation; a comparative study[20]. The advantages of single incision method included less anaesthesia time, less surgical time and less blood loss. The study concluded that for type I floating knee injury, single-incision technique is a safe and faster alternative procedure.

Szalay MJ, Hosking OR, Annear P did a study on the injury of the knee ligaments associated with ipsilateral femoral shaft fractures and with ipsilateral femoral and tibial shaft fractures[21]. The anterior cruciate ligament was more commonly injured with/without other ligamentous injury**. They concluded that ipsilateral fractures of femur and tibia shows more knee injury than femoral fracture alone.**

Hung SH et al[23], did a study on the surgical treatment of type II floating knee: Comparison on the results of type IIA and type IIB floating knees. The study concluded that poor outcome of type II floating knee is due to the intra articular knee involvement.

Yokoyama K et al[24] conducted the study to evaluate the significant contributing factors affecting the functional prognosis of floating knee injuries using multivariate analysis. The study included 67 patients. The study period was from 1968-91. Various surgical methods were followed. The results were classified according to Karlstrom and Olerud criteria. The study concluded that the involvement of the knee joint and severity grade of the soft tissue injury of tibia are the significant risk factors of poor outcome.

Hee HT, Wong HP, Low YP, Meyers L[25], conducted a study on the predictors of outcome of floating knee injuries in adults. 89 patients with floating knee injuries were analyzed which included 80 male and 9 female patients. The study was conducted from 1987-97. Increasing age was associated with delayed bone union and full weight bearing ability. Increasing number of pack years smoked showed knee stiffness, delay in bony union and full weight bearing ability. Higher injury severity scores were associated with delayed full weight bearing ability. Open fractures were associated with knee stiffness and delayed full weight bearing ability. Comminuted fractures were associated with malunion. Segmental fractures were associated with delayed bony union. According to Karlstrom and Olerud's criteria they classified the results.

In 1977 Hojer et al[28] conducted a prospective study on ipsilateral femur and tibia shaft fractures. They had immediately fixed tibia with either internal or external fixation. But the femur fixation was delayed by seven to fourteen days and was fixed with intramedullary nail. They had excellent functional results in majority of their patients.

Della Rocca GJ et al[30] did a study on conversion of external fixation to intramedullary nailing for closed fractures of the femoral and tibial shaft. They had analyzed the time interval between the conversion of the fixations. They concluded that the management of closed femoral and tibial diaphyseal fractures with external fixation then conversion to intramedullary nailing should be based on the condition of the given limb. They also mentioned that external fixation can be a definitive treatment for floating knee in paediatric population.

Anoop Kumar et al[31] did a study on ipsilateral femur and tibia fractures in forty two patients. The treatment comprised of external fixators and internal fixators depending upon the type of fractures. **They concluded that poor outcome was seen in patients with compound injuries and juxta articular fractures.** Excellent results were seen in patients treated with rigid internal fixation.

Kao FC et al[33] conducted a retrospective study on 419 floating knee injury patients with regard to the complications. **They concluded that the complication rate was high regardless of the treatment done.** They insist that the operating surgeons should focus on reducing the complications while treating these injuries.

Anatomy

RELEVANT ANATOMY OF LOWER LIMB

FEMUR

The femur is the strongest and longest bone in the human body (Figs). Femur length is associated with a striding gait, and its strength is associated with the weight and muscular forces, required to withstand.

Femur shaft, almost cylindrical along most of its length, is bowed forward. It has a proximal rounded, articular head projecting medially from its short neck, which is a medial extension of the proximal shaft. The distal extremity is wider and presents a double condyle that articulates with the tibia. The femur consists of a head, neck, greater and lesser trochanters proximally.

Fig no .1 Normal anteversion of neck

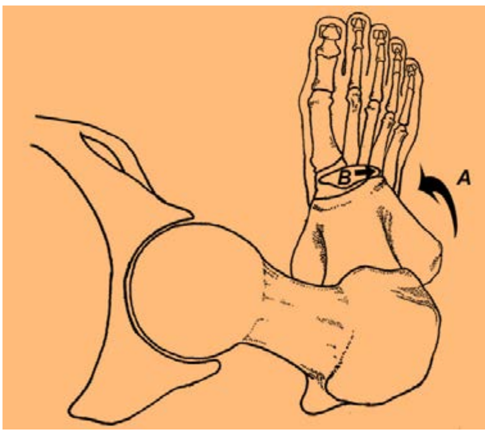


Fig no.2 Normal anterolateral bowing of femur

Shaft of femur

The shaft which is surrounded by muscles, is impalpable (Figs). Distal and anteriorly, for 5–6 cm above the patellar articular surface, it is covered by a suprapatellar bursa, between bone and muscle. The distal lateral surface is covered by vastus intermedius and lateralis. The medial surface, devoid of attachments, is covered by vastus medialis. The shaft is narrowest at proximal/middle third junction (isthmus) and expands a little at its proximal end, and substantially more at its distal end. Its long axis makes an angle of approximately 10° with the vertical, and diverges about 5–7° from the long axis of the tibia.

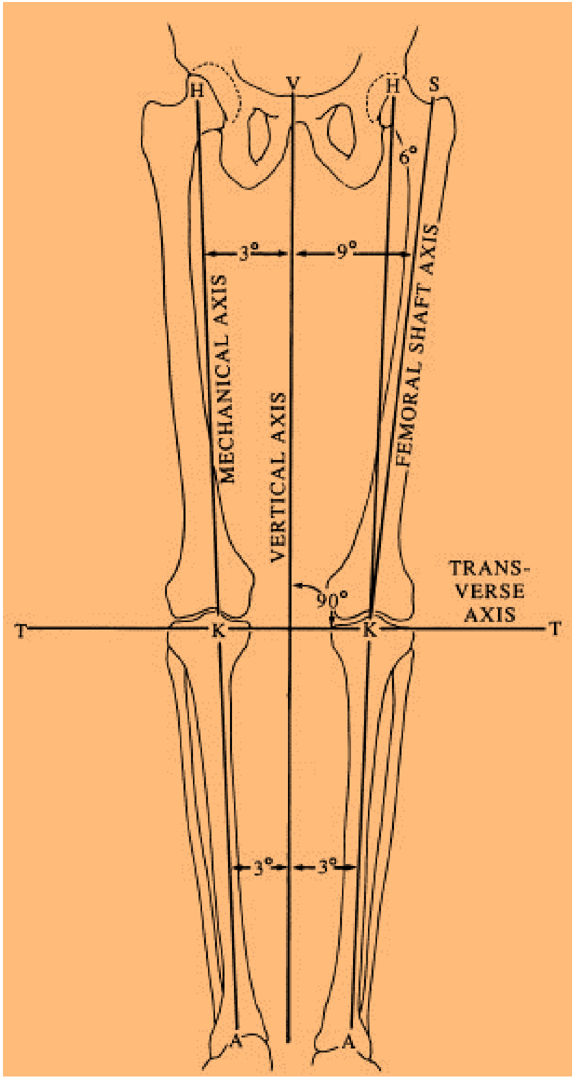


Fig no . 3. Mechanical axis and anatomical axis of lower limb

Its middle third has three borders and surfaces. The extensive anterior surface, smooth and gently convex, is between the lateral and medial borders, which are both round and not sharply defined. The posterolateral surface is bounded posteriorly by the broad, rough linea aspera,which is usually a crest with lateral and medial edges. Its subjacent compact bone is made bigger to withstand compressive forces, which are concentrated here by the anterior curvature of the shaft. Adductor longus, intermuscular septa and the short head of biceps femoris gets attached to linea aspera, all inseparably blended at their attachments. Perforating arteries crosses the linea laterally below tendinous arches in adductor magnus and biceps femoris. Nutrient foramina, directed proximally, appear in the linea aspera, varying in number and site, one which is usually near its proximal end, a second usually near its distal end. The posteromedial surface, which is smooth like the others, is bounded in front by the indistinct medial border and behind by the linea aspera.

In its proximal third the shaft has a fourth, posterior surface, bounded medially by a narrow, rough spiral line that is continuous proximally with the intertrochanteric line, distally with the medial edge of linea aspera. Laterally this posterior surface is limited by the broad, rough, gluteal tuberosity, ascending a little laterally to the greater trochanter and descending to the lateral edge of the linea aspera. In its distal third the posterior surface of the shaft has a further surface, the popliteal surface between the medial and lateral supracondylar lines. These supracondylar lines are continuous above with the corresponding edges of the linea aspera. The lateral line is the most distinct in its proximal two-thirds, where the short head of biceps femoris and lateral intermuscular septum are attached. Its distal third has a tiny rough area for the attachment of plantaris, often encroaching on the popliteal surface. The medial line is not clear in its proximal two-thirds, where vastus medialis is attached. On the distal aspect, the medial line is crossed obliquely by the femoral vessels entering the popliteal fossa from the adductor canal. Further distally, the line is often sharp for 3 or 4 cm and proximal to the adductor tubercle.

The popliteal surface, which is triangular in outline, lies between the medial and lateral supracondylar lines. Distally its medial part is rough and slightly elevated. Forming the proximal part of the floor of the popliteal fossa, the popliteal surface is covered by a variable amount of fat which separates the popliteal artery from bone. The superior medial genicular artery, which is a branch of the popliteal artery, arches medially above the medial condyle. It gets separated from bone by the medial head of gastrocnemius. The latter is attached a little above the condyle; further distally there is a smooth facet underlying a bursa for the medial head of gastrocnemius. Medially, there is often an imprint proximal to the articular surface: in flexion this is close to a rough tubercle on the medial tibial condyle which is for the attachment of semimembranosus. The superior lateral genicular artery arches up laterally proximal to the lateral condyle and is separated from bone by the attachment of plantaris to the distal part of the lateral supracondylar line.

Fig no. 4 . anterior surface of femur and attachments

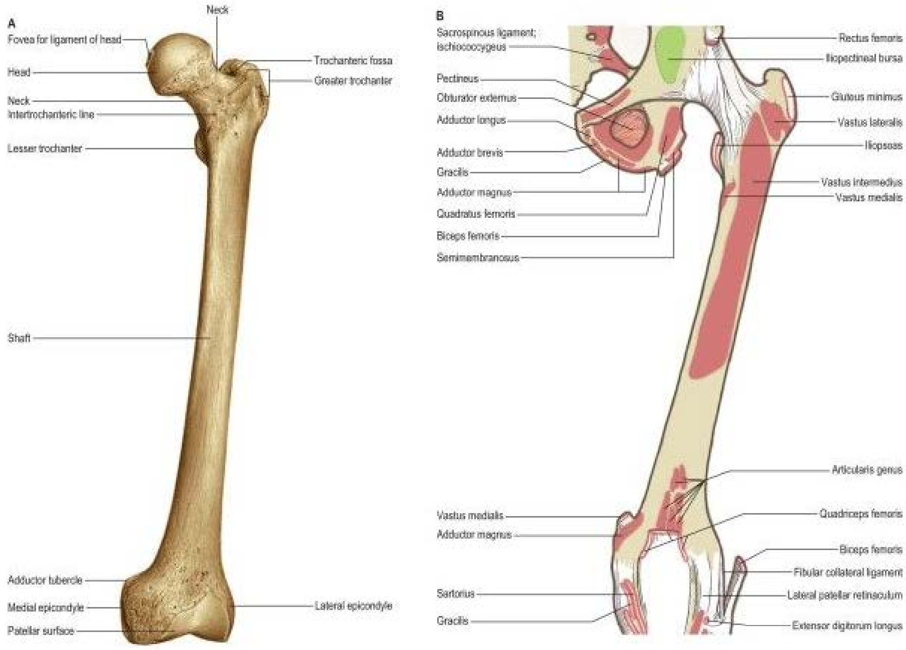
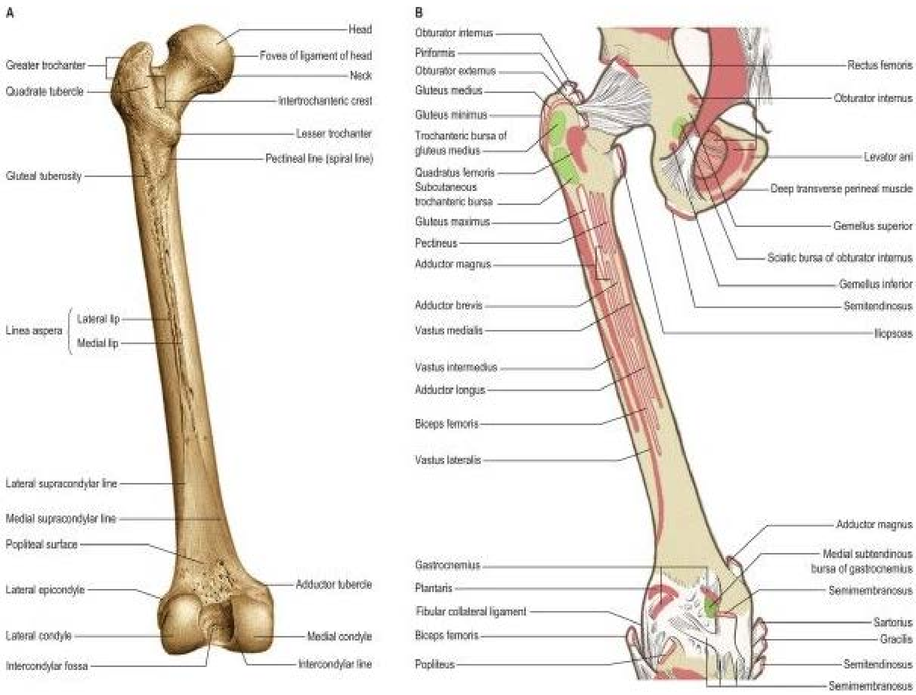


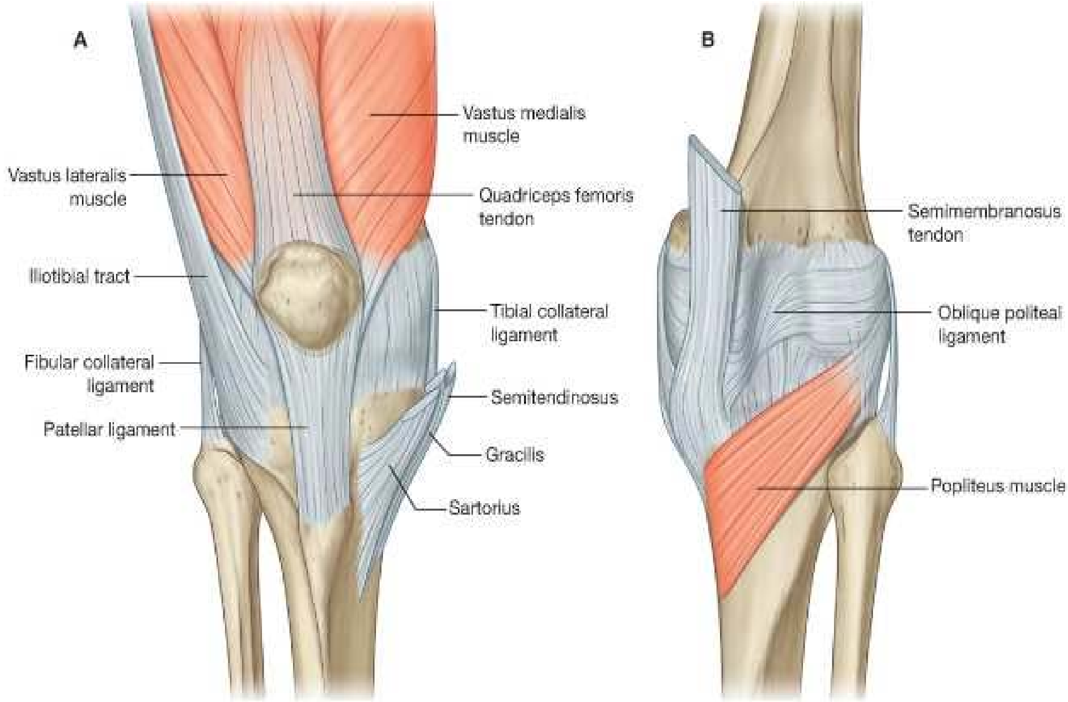
Fig no.5. posterior surface of femur and attachments



FEMORAL CONDYLES

The femoral condyles are asymmetrical both in size and shape. The medial femoral condyle is about 1.7 cm longer than the lateral one. In the sagittal plane the lateral femoral condyle extends anteriorly than the medial condyle and in coronal plane the medial femoral condyle extends more distally than the lateral condyle. However in normal weight bearing alignment the condyles both appear to be equal in level. The parallel femoral condylar surfaces are created by the mechanical axis configuration of the lower extremity. The weight bearing axis - a straight line starting from the centre of femoral head that intersects the centers of the knee and ankle joints. The distal femoral joint line forms a 6^0 valgus angle to the long axis of the femoral shaft, which creates physiological valgus at knee.

Fig no.6 Muscles around the knee



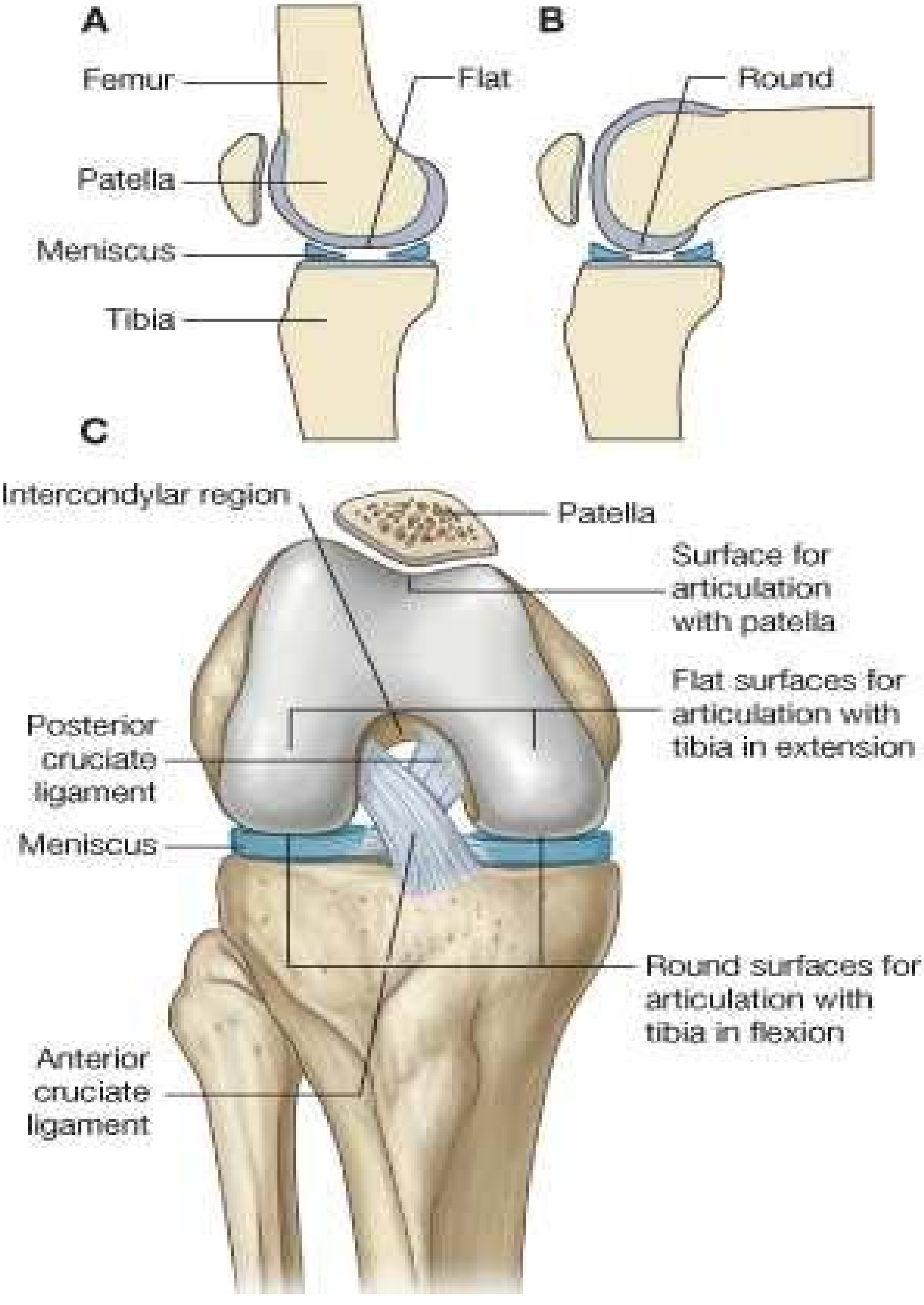


Fig no.7. KNEE FLEXION/EXTENSION, FEMORAL CONDYLES

TIBIA

The tibia lies medial to the fibula and is exceeded in length only by the femur (Figs). Its shaft is triangular in section and has got expanded ends; a strong medial malleolus projects distally from the smaller distal end. The anterior border of the shaft is sharp known as the shin and it curves medially towards the medial malleolus. Together with the medial and lateral borders it forms the three surfaces of the bone. The exact shape and orientation of these surfaces show individual and racial variations.

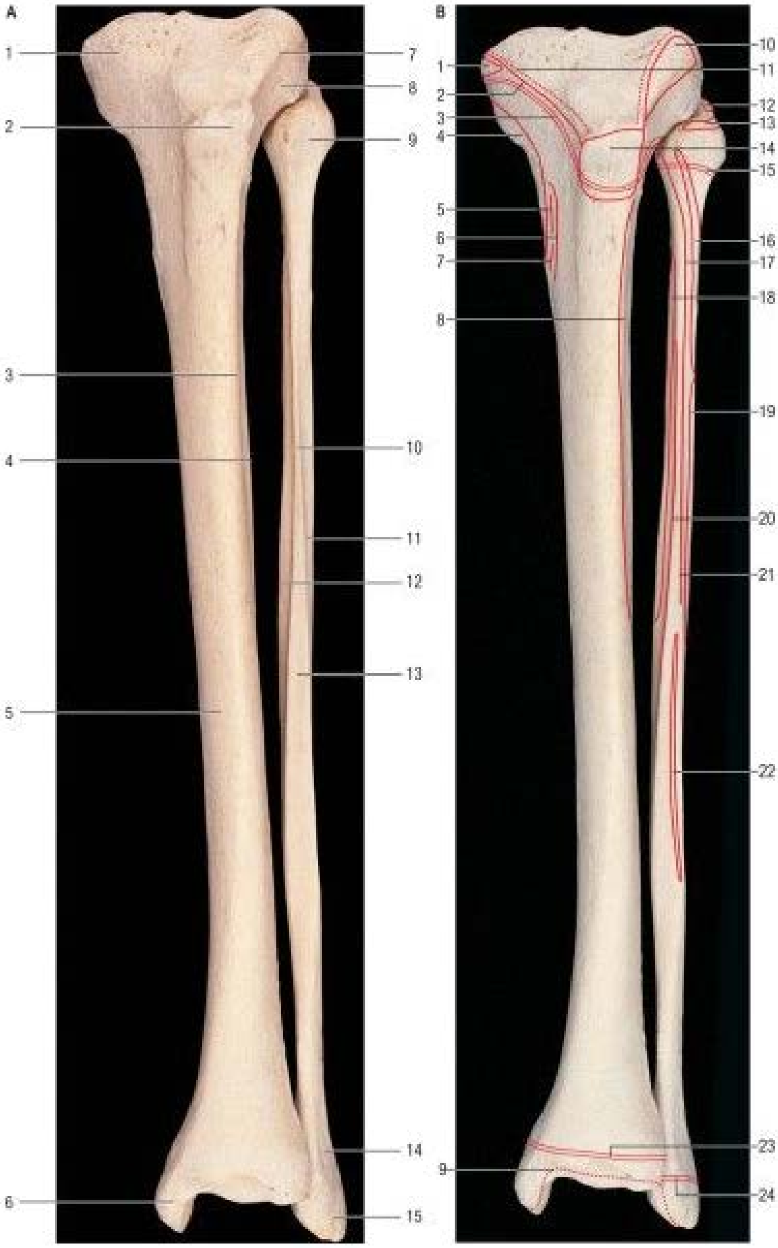


Fig. 8, Left tibia and fibula: anterior aspect. B, The muscle attachments. A: 1. Medial condyle. 2. Tibial tuberosity. 3. Anterior border of tibia. 4. Interosseous border of tibia. 5. Medial surface. 6. Medial malleolus. 7. Gerdy's tubercle. 8. Lateral condyle. 9. Head of fibula. 10. Interosseous border of fibula. 11. Anterior border of fibula. 12. Medial crest. 13. Anterior surface. 14. Subcutaneous area. 15. Lateral malleolus. B: 1. Semimembranosus. 2. Medial patellar retinaculum. 3. Epiphysial line (growth plate). 4. Medial collateral ligament. 5. Gracilis. 6. Sartorius. 7. Semitendinosus. 8. Tibialis anterior. 9. Capsular attachment. 10. Iliotibial tract. 11. Capsular attachment. 12. Lateral collateral ligament. 13. Biceps femoris. 14. Patellar tendon. 15. Epiphysial line (growth plate). 16. Fibularislongus. 17. Extensor digitorumlongus. 18. Tibialis posterior. 19. Fibularisbrevis. 20. Extensor hallucislongus. 21. Extensor digitorumlongus. 22. Fibularistertius. 23. Epiphysial line (growth plate). 24. Epiphysial line (growth plate).

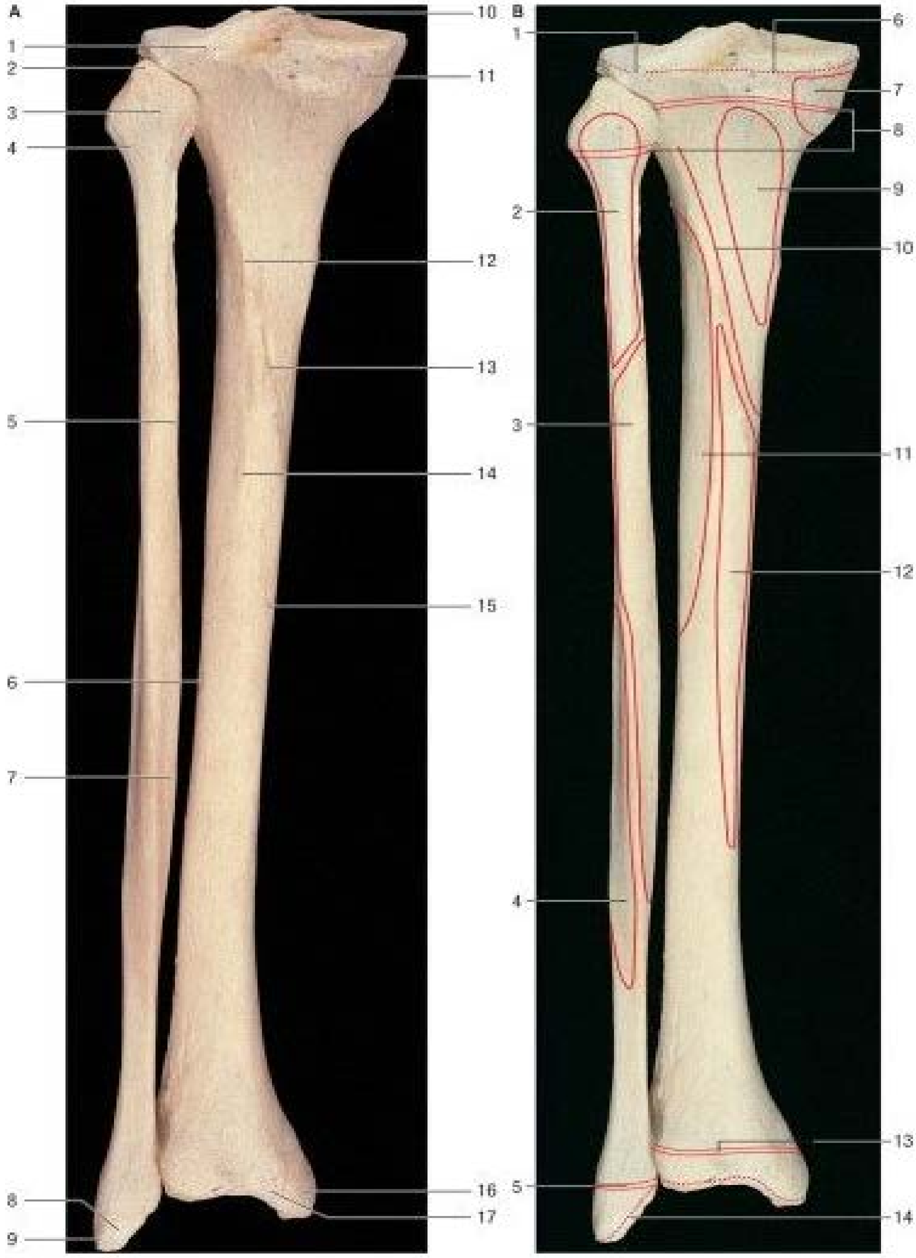


Fig.9, Left tibia and fibula: posterior aspect. B, The muscle attachments. A: 1. Groove for tendon of popliteus. 2. Styloid process (apex) of fibula. 3. Head of fibula. 4. Neck of fibula. 5. Medial crest. 6. Interosseous border of tibia. 7. Posterior border. 8. Groove for fibular tendons. 9. Lateral malleolus. 10. Intercondylar eminence. 11. Groove for semimembranosus attachment. 12. Soleal line. 13. Nutrient foramen. 14. Vertical line. 15. Medial border of tibia. 16. Medial malleolus. 17. Groove for tibialis posterior tendon. B: 1. Gap in capsule for popliteus tendon. 2. Soleus. 3. Flexor hallucislongus. 4. Fibularisbrevis. 5. Epiphysial line (growth plate). 6. Capsular attachment. 7. Semimembranosus. 8. Epiphysial lines (growth plates). 9. Popliteus. 10. Soleus. 11. Tibialis posterior. 12. Flexor digitorumlongus. 13. Epiphysial line (growth plate). 14. Capsular attachment.

Proximal end

The expanded proximal end is the bearing surface for body weight, which is transmitted through the femur. It consists of both medial and lateral condyles, an intercondylar area and the tibial tuberosity.

Condyles

The tibial condyles overhang the proximal part of the posterior surface of the shaft and both condyles have articular facets on their superior surfaces that are separated by an irregular, non-articular intercondylar area. The condyles are visible and palpable at the sides of the patellar tendon, the lateral being more prominent of the two. In the passively flexed knee the anterior margins of the condyles are palpable in fossae that lie on the side of patellar tendon.

The fibular facet on the posteroinferior aspect of the lateral condyle faces more distally and posterolaterally. The angle of inclination of the superior tibiofibular joint varies from one individual to other, and may be horizontal or oblique. Superomedial to it the condyle is grooved on its posterolateral aspect by the tendon of popliteus; a synovial recess intervenes between the tendon and bone. The anterolateral aspect of the condyle is separated from the lateral surface by a sharp margin for the attachment of deep fascia. The distal attachment of the iliotibial tract makes a flat and definite marking, Gerdy's tubercle, on its anterior aspect. This tubercle, which is triangular and facet-like, is usually palpable.

The anterior condylar surfaces are continuous with a large triangular area whose apex is distal and is formed by the tibial tuberosity. The lateral edge is a sharp ridge lying between the lateral condyle and lateral surface of the shaft.

Tibial tuberosity

The tibial tuberosity is the truncated apex of a triangular area where the anterior condylar surfaces meet. It projects only a little, and is divided into a proximal smooth and distal rough region. The distal region is palpable which is separated from skin by the subcutaneous infrapatellar bursa. A line across the tibial tuberosity marks the distal limit of the proximal tibial growth plate. The patellar tendon is attached to the smooth bone proximal to this, with its superficial fibres reaching a rough area distal to the line. The deep infrapatellar bursa and fibro adipose tissue comes in between the bone and tendon proximal to its site of attachment. The latter can be marked distally by a somewhat oblique ridge, onto which the lateral fibres of the patellar tendon are inserted more distally than the medial fibres. (This knowledge is necessary in order to avoid damaging the tendon when sawing the tibia transversely just above the tibial tuberosity in a lateral to medial direction, e.g. in performing an osteotomy.) In habitual squatters a vertical groove on the anterior surface of the lateral condyle is occupied by the lateral edge of the patellar tendon in full flexion of the knee.

Shaft : The shaft which is triangular in section and has (antero)medial, lateral and posterior surfaces separated by anterior, lateral (interosseous) and medial borders. It is narrowest at the junction of the middle and distal thirds, and expands gradually towards both the ends. The anterior border descends from the tuberosity to the anterior margin of the medial malleolus which is subcutaneous throughout. Except in its distal fourth, where it is not clearly defined, it is a sharp crest. It is slightly sinuous, and turns medially in the distal fourth. The interosseous border begins distal and anterior to the fibular facet and it descends to the anterior border of the fibular notch; it is indistinct proximally. The interosseous membrane is attached to most of its length and connecting tibia to fibula. The medial border descends from the anterior end of the groove on the medial condyle to the posterior margin of the medial malleolus. Its proximal and distal fourths are ill defined but its central region is sharp and distinct.

The posterior surface, between the interosseous and medial borders, is widest above, from where it is crossed distally and medially by an oblique, rough soleal line. A faint vertical line descends along the centre of the soleal line for a short distance before becoming indistinct. A large vascular groove joins the end of the line and then descends distally into a nutrient foramen. Deep fascia and, proximal to the medial malleolus, the medial end of the superior extensor retinaculum, are all attached to the anterior border. Posterior fibres of the medial collateral ligament and slips of semimembranosus and the popliteal fascia are attached to the medial border proximal to the soleal line, and some fibres of soleus and the fascia covering the deep calf muscles are attached distal to the line. The distal medial border runs into the medial lip of a groove for the tendon of tibialis posterior. The interosseous membrane is attached to the lateral border, except at either end of this border. It is indistinct proximally where a large gap in the membrane transmits the anterior tibial vessels. Distally the border is continuous with the anterior margin of the fibular notch, to which the anterior tibiofibular ligament is attached.

The anterior part of the medial collateral ligament is attached to an area approximately 5 cm long and 1 cm wide, near the medial border of the proximal medial surface. The remaining medial surface is subcutaneous and crossed obliquely by the long saphenous vein. Tibialis anterior is attached to the proximal two-thirds of the lateral surface. The distal third, devoid of attachments, is crossed in mediolateral order by the tendons of tibialis anterior (lying just lateral to the anterior border), extensor hallucis longus, the anterior tibial vessels and deep fibular nerve, extensor digitorum longus and fibularis tertius.

On the posterior surface, popliteus is attached to a triangular area proximal to the soleal line, except near to the fibular facet. The popliteal aponeurosis, soleus and its fascia, and the deep transverse fascia are all together attached to the soleal line: the proximal end of the line does not reach the interosseous border, which is marked by a tubercle for the medial end of the tendinous arch of soleus. Lateral to the tubercle, the posterior tibial nerve and tibial vessels descend on tibialis posterior. Distally to the soleal line, a vertical line separates the attachments of flexor digitorum longus and tibialis posterior. Nothing is attached to the distal quarter of this surface, but the area is medially crossed by the tendon of tibialis posterior travelling to a groove on the posterior aspect of the medial malleolus. Flexor digitorum longus crosses obliquely beneath tibialis posterior; the posterior tibial vessels and nerve and flexor hallucis longus contact only the lateral part of the distal posterior surface.

Muscle attachments

The patellar tendon is attached to the proximal half of tibial tuberosity. Semimembranosus is attached to the distal edge of the groove which is on the posterior surface of the medial condyle; a tubercle at the lateral end of the groove is the main attachment of the tendon of this muscle. Slips arising from the tendon of biceps femoris are attached to the lateral tibial condyle anteroproximal to the facet of fibula. Proximal fibres of extensor digitorum longus and (occasionally) fibularis longus are attached distally to this area. Slips of semimembranosus are attached to the medial border of shaft posteriorly, proximal to the soleal line. Some fibres of soleus gets attached to the posteromedial surface distal to the line. Semimembranosus is attached to the medial surface proximally, near to the medial border, behind the attachment of the anterior part of the medial collateral ligament. Anterior to this area (in anteroposterior sequence), are the linear attachments of the tendons of gracilis, sartorius and semitendinosus: which rarely mark the bone. Tibialis anterior is attached to the proximal two-thirds of the lateral (extensor) surface and Popliteus is attached to the posterior surface in a triangular area proximal to the soleal line, except near the fibular facet. Soleus along with its associated fascia are attached to the soleal line itself. Flexor digitorum longus and tibialis posterior are both attached to the posterior surface distal to the soleal line, medial and lateral respectively to the vertical line.

TIBIAL PLATEAU

The tibial joint surface is very complex. A normal tibial articulation includes the menisci to provide stability to the distal femoral condyles. The menisci functions to create balance between the flat tibial and curved femoral surfaces. Biomechanically the menisci function is to decrease the stress concentration of tibiofemoral contact by increasing the surface area of contact between the femur and tibia during weight bearing. Without the menisci, the tibial and femoral articular surfaces would carry similar forces distributed over smaller surface area resulting in stress concentration. The medial condyle is almost flat and has a larger surface area than the lateral condyle. The lateral condyle surface is slightly convex. Both tibial condyles have a 10^0 posterior inclination to the tibial shaft in the sagittal plane. Bordering the femoral notch are the medial and the lateral tibial spines which stabilize the tibia from moving sideways. The interspinous area is devoid of hyaline cartilage and is the site of insertion for the meniscal horns and cruciate ligaments. The cruciate ligaments insert on to this intertubercular sulcus and not on the tibial spine themselves.

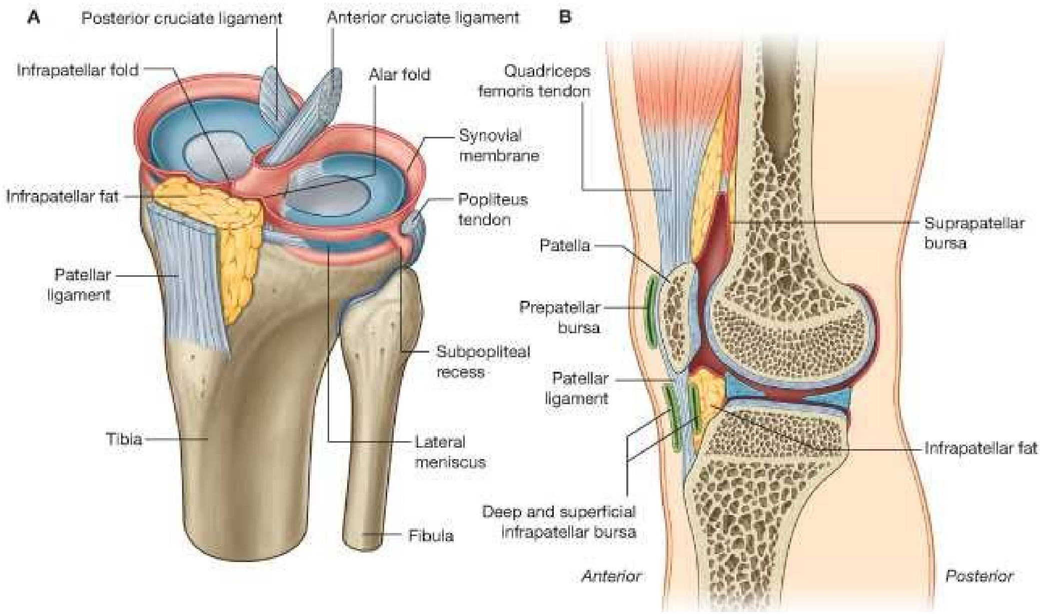


FIG NO.10. PROXIMAL TIBIA

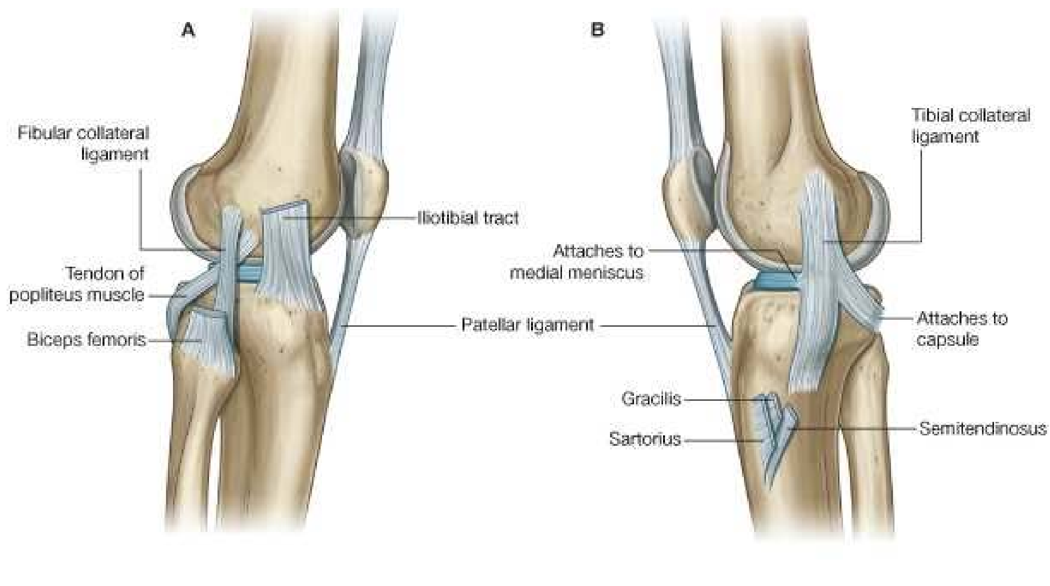


FIG NO.11. LIGAMENTS AROUND THE KNEE

BLOOD SUPPLY

Vascular supply to the knee is a complex anastamosis of two separate systems called the intrinsic and extrinsic networks. The intrinsic supply is an anastamotic ring made up of the articular, muscular and five geniculate arteries (superomedial, superolateral, middle, inferomedial and inferolateral). The extrinsic system is made up of the descending branch of superficial femoral artery, recurrent branch of anterior tibial artery and the descending branch of the lateral femoral circumflex artery.

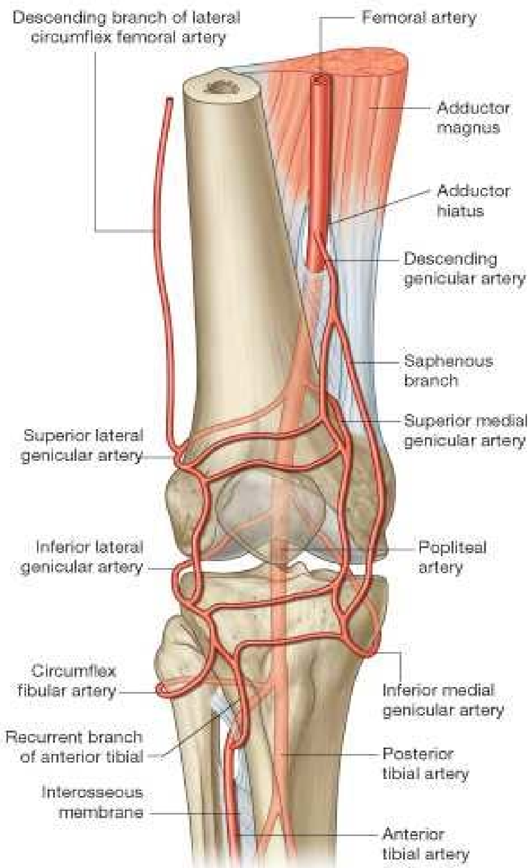


FIG NO.12. BLOOD SUPPLY AROUND THE KNEE

NERVE SUPPLY

Nerve supply to the knee is from sciatic nerve and from branches of femoral nerve.

LIGAMENTS AROUND THE JOINT

The ligaments of the knee joint are divided functionally into a three layer system.

FIRST LAYER

This is the fascial layer which is the most superficial. It is made up of the sartorius fascia medially, iliotibial band and biceps femoris laterally.

SECOND LAYER

This contains all of the patellar tendon, the superficial medial collateral ligament and the lateral collateral ligament.

THIRD LAYER

This is made up of the joint capsule including its functional capsular

thickenings, the posterior oblique ligament, arcuate ligament and deep medial collateral ligament. The anterior cruciate ligament is attached both on the posterior and lateral aspect of the femoral notch as a semicircle rotated 25 degrees from long axis of the femoral shaft. The insertion of the anterior cruciate ligament on the tibia is narrow and long, measuring almost 30 mm in length with attachments to the anterior horn of lateral meniscus. It has a synovial envelope and has been described as being extra synovial but intra articular. It is vascularised by middle geniculate artery. It has two parts, the anteromedial and posterolateral band. The posterior cruciate ligament originates from two anatomic sites on the anterior aspect of the medial femoral notch. It has two bundles, the anterolateral and posteromedial which are named by the relative position of origin and insertion. The anterolateral bundle originates from the anterior aspect of the femur and inserts on the lateral aspect of tibia. The posteromedial bundle originates posterior to the anterolateral bundle on the femur and gets inserted medial to it on the tibia.

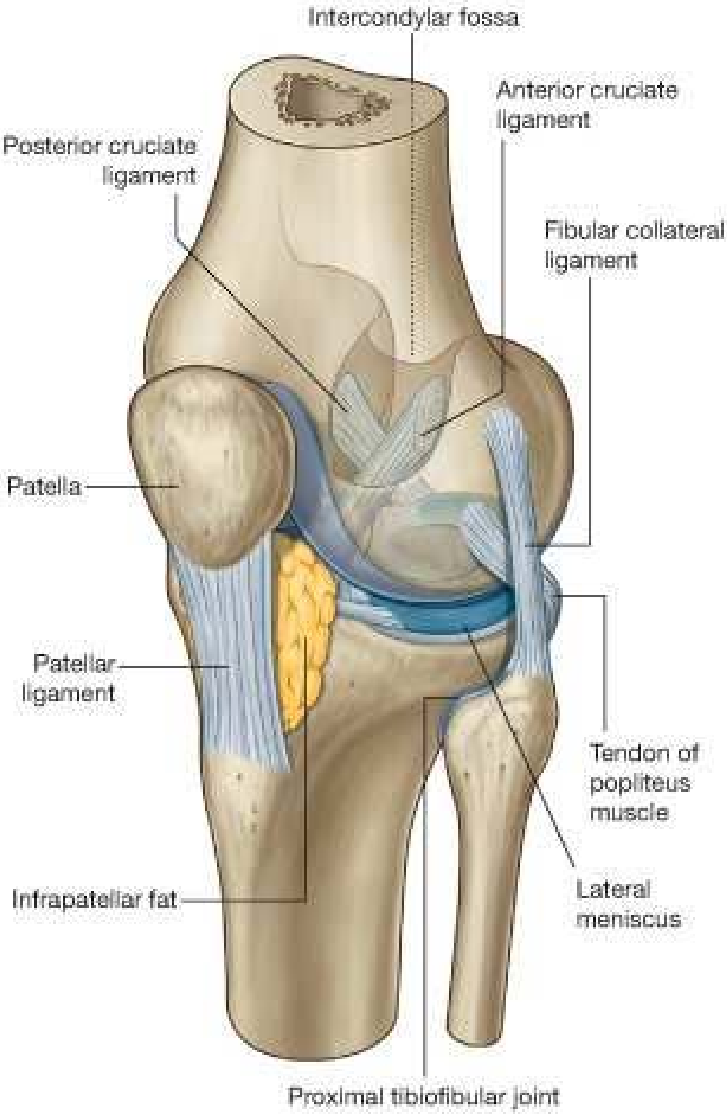


FIG NO.13. RELATION OF ACL AND PCL

MENISCUS

The basic functions of the menisci are joint stabilization, tibio-femoral stress reduction and joint nutrition. The meniscus which is a tibial extension creates conformity between the relatively flat tibial surface and the round femoral condyles. Menisci are made up of both type- I collagen with some type- III collagen. Collagen fibres lie in circumferential loops and radial arrangements which help to create the structure of the menisci.The Circumferential fibers function in hoops to accept stress while the radial fibres stabilize the meniscus, preventing circumferential splits as well as resisting excessive compressive loads.

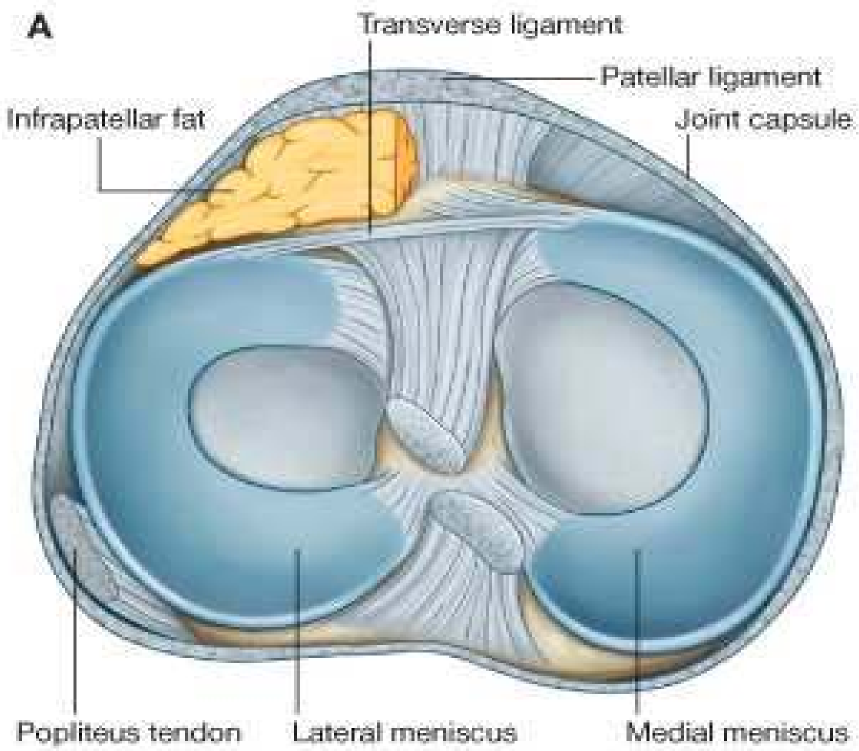


FIG NO.14. MENISCI OF THE KNEE

MUSCLES

The quadriceps is composed of four muscles and are the rectus femoris, vastus lateralis, vastus medialis and vastus intermedius. They have a common tendinous insertion on the patella. The rectus femoris crosses the hip joint originating from the anterior inferior iliac spine and forms the anterior portion of the quadriceps muscle tendon group. The vastus lateralis originates from the lateral surface of femur along the lateral intermuscular septum and the linea aspera. It has attachments to both the lateral aspect of patella and has an expansion to the iliotibial tract. The vastus medialis originates from the medial surface of proximal femur and get inserted into the common tendon as well as the medial portion of the patella. The lower portion of vastus medialis gets originated from the tendon of the adductor magnus with the transverse fibres inserting into the patella. This part is known as vastus medialis obliqus. The vastus intermedius is arising from the anterior surface of femoral shaft and blends with the medialis musculature and tendinous insertion. Quadriceps muscle forms a trilaminar tendon, with the rectus anteriorly, vastus medialis and intermedius in the intermediate layer and the vastus lateralis in the deep layer. The hamstring musculature is composed of the gracilis, semitendinosus and the semimembranosus medially and biceps femoris laterally. On the medial side the semimembranosus has got a separate insertion and the gracilis and semitendinosus combine with the sartorius to create pes anserinus. The gastrocnemius is made up of two muscle bellies the medial and lateral. Both muscle bellies originate above the respective femoral condyles in the area of distal femoral physis. The tendinous part combines with the common tendon of soleus to form tendo achilles. The motor function about the knee is important in understanding the gait as well as dynamic knee joint stability. The specific function of the quadriceps and hamstrings during walking is not to produce extension and flexion respectively, but really the reverse. At heel strike the quadriceps eccentrically contracts thereby allowing controlled flexion of the knee, absorbing impact energy. Likewise the hamstrings muscles fire eccentrically during swing phase to slow down the leg in preparation for heel strike, creating controlled extension of the knee. The gastrocnemius also plays important functions in the gait cycle. Although a strong knee flexor, it functions is eccentrically to decelerate the leg and body for heel strike. Once in stance phase the gastrocnemius controls the knee flexion to prevent a back knee gait and finally at toe it fires concentrically in conjunction with the soleus for producing push off[3].

RELEVANT PHYSIOLOGY AND TRAUMA PRINCIPLES

Physiological response to trauma

Human body responds to trauma in predictable stages. In recent days, much knowledge has been obtained in the field of molecular biology which helps us to understand these stages and inflammatory mediators associated with it. Immediately following a trauma, there is an increase in these inflammatory mediators especially the cytokines. The importance of these cytokines is that they are prognostic markers in polytrauma and multiply injured victims and by studying their levels patient can be stratified into one having increased risk of having second hit or not.

The clinically important cytokines are mainly TNF-alpha and IL-6 . TNF – alpha which has very short half- life is not a good marker. IL-6 is the sensitive marker and the level of which correlates directly with the inflammatory phase of trauma taking place in the body.

All these physiological courses following trauma is therefore determined by these factors:

1) Initial trauma (first hit)
2) Patient's genetic constitution
3) Any secondary intervention procedures (second hit)

INITIAL TRAUMA (PRIMARY /FIRST HIT)

In severe cases

Systemic inflammatory response syndrome

SECOND HIT

Resolution MODS/ARDS

The plasma half life of TNF – alpha is 14 – 18 minutes and it has various binding proteins making its measurement relatively less significant.

An early higher elevation of IL – 6 found to match more with the subsequent development of MODS or ARDS. The level of IL – 6 once elevated may remain higher for about 5 days following trauma in patients with multiple or severe injuries.

Initial level of IL – 6 > 800 pg/ml signifies the risk of developing MODS if any lengthier intervention is going to be performed in these patients. And so the concept of Damage control Orthopaedics came into existence. ''Do no further harm'' is the basis for this concept.

Priorities in managing these patients starts with addressing life saving problems to immobilisation of fractures by as shorter intervention as possible in the form of splinting/external fixator.

Theories associated with ARDS and MODS following polytrauma

There are so many theories to explain the physiological consequences following trauma . These include

Macrophage activation theory: after a primary insult the macrophages are activated producing the mediators of inflammation initiating a cascade of events resulting in systemic inflammatory response syndrome.

Microvascular theory: hypotensive state following trauma incite a microvascular insult due to reactive oxygen species.

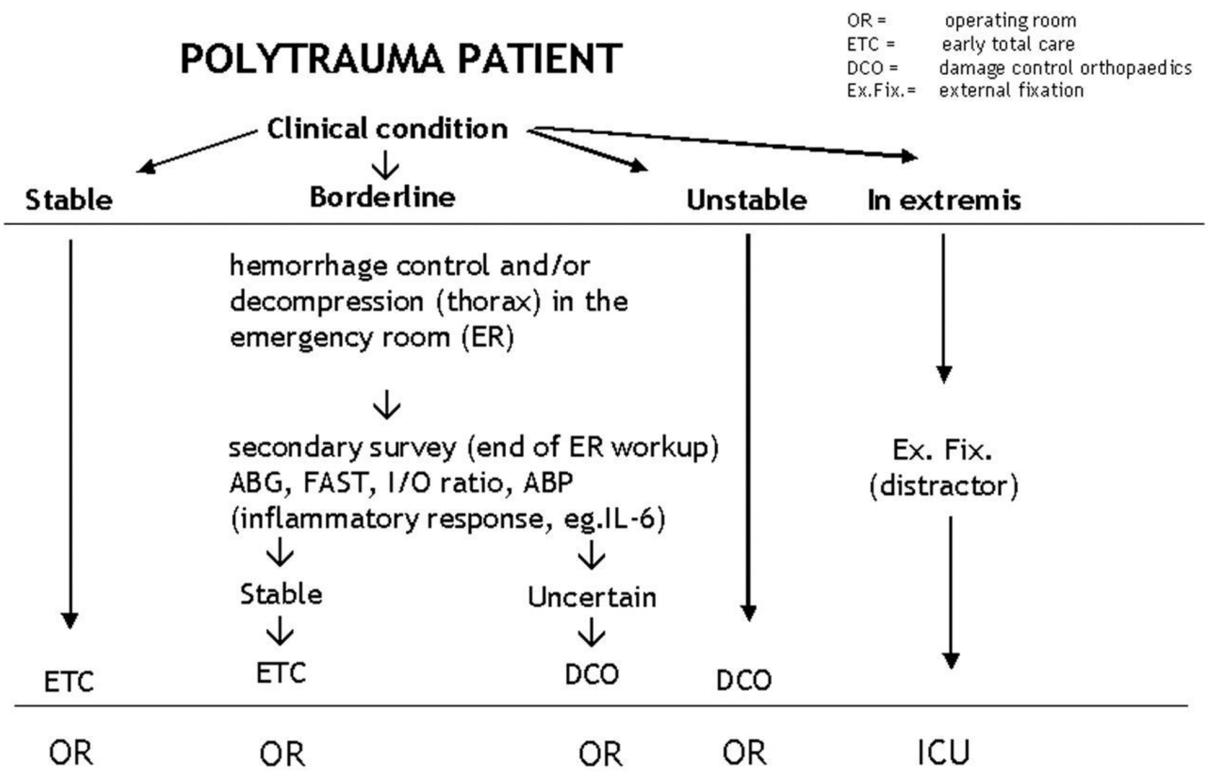
Endothelial theory: the microvascular insult evoke an interaction between the capillary endothelium and the circulating leucocytes and production of various cytokines and immune regulators.

Gut theory: bacterias present in the gut contributing to MODS

Single and double hit theory : an intense initial trauma provoking SIRS is a single hit phenomena. Whereas a mild primary insult which may perpetuate to overt SIRS following further insult is a double hit phenomena.

Lung is the primary organ involved followed by liver,GIT and renal system.

Management of multiply injured trauma victims



Classification

CLASSIFICATION OF FLOATING KNEE INJURIES

1) **MODIFIED FRASER CLASSIFICATION**

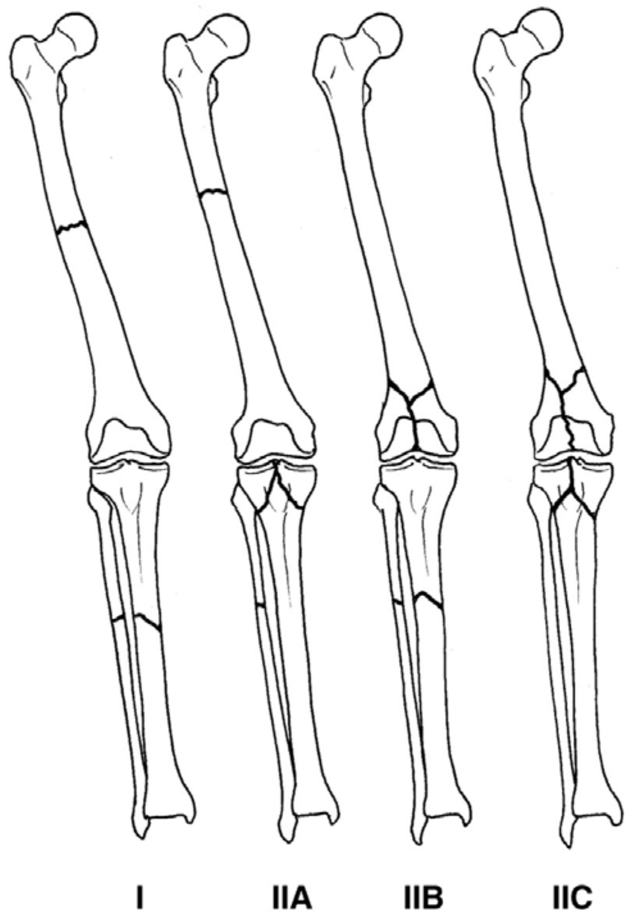


Fig No.15 – Modified Fraser classification

Type I – both femur and tibial side shaft fractures

Type II A – femur – shaft fracture

tibia – intra articular fracture

Type II B – femur – intra articular type

tibia - shaft fracture

type II C – both femur and tibia – intra -articular

2) BLAKE AND MC BRYDE'S CLASSIFICATION OF FLOATING KNEE INJURIES[4]

TYPE 1 : TRUE FLOATING KNEE

The knee joint is isolated completely and not involved, with either shafts fractured.

TYPE 2 : VARIANT FLOATING KNEE

Involves one or more joints with either shafts fractured.

2A : The knee joint alone is involved

2B : Involves the hip or ankle joint.

3) LETTS CLASSIFICATION OF FLOATING KNEE INJURIES[1]

Type A fractures - both diaphyseal and closed.

Type B fractures - closed, metaphyseal in one bone and diaphyseal in the other.

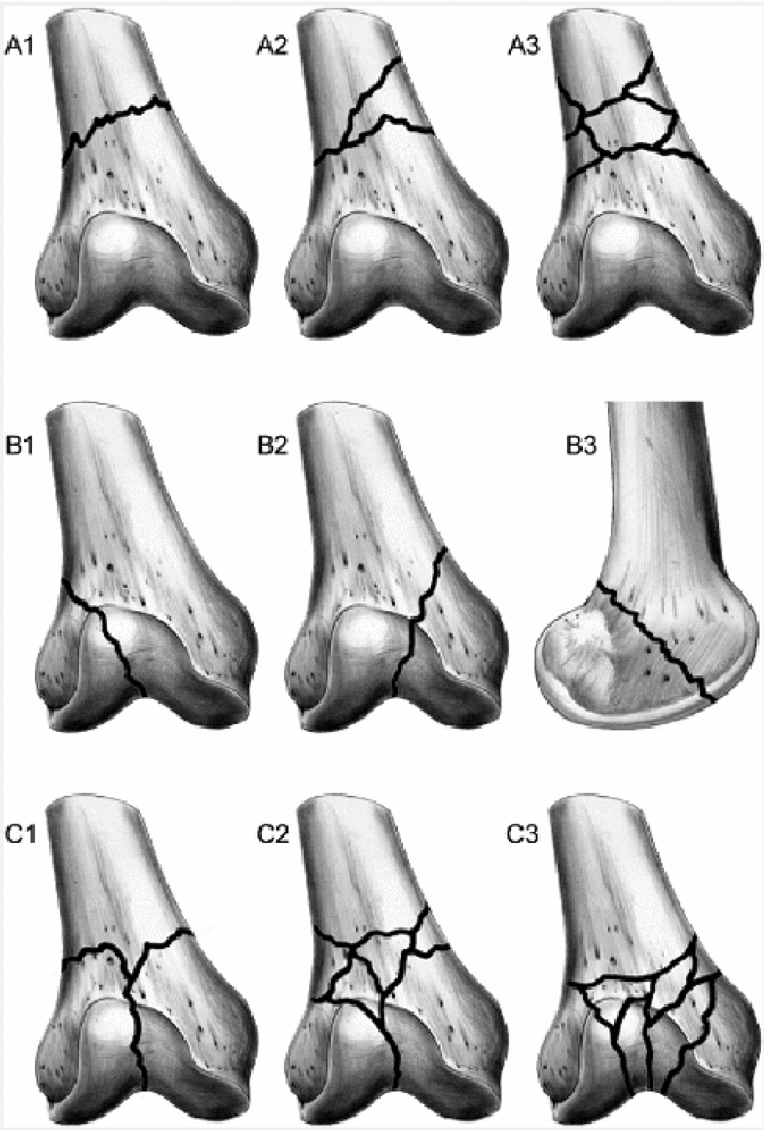
Type C fractures - closed, one bone has an intra-articular extension of the fracture, regardless of the site in the other bone.

Type D fractures - one open fracture, regardless of the site.

Type E fractures - both open fractures, regardless of the location.

4) AO CLASSIFICATION FOR DISTAL FEMUR FRACTURES[37]

Fig no.16



A – Extraarticular fracture (metaphyseal region)

B – Partial articular involving either of the condyle

(B1 – lateral femoral condyle

B2- medial femoral condyle

B3 – coronal fracture – Hoffa's fracture)

C- Complete articular

5) SCHATZKAR CLASSIFICATION FOR PROXIMAL TIBIAL FRACTURES[38]

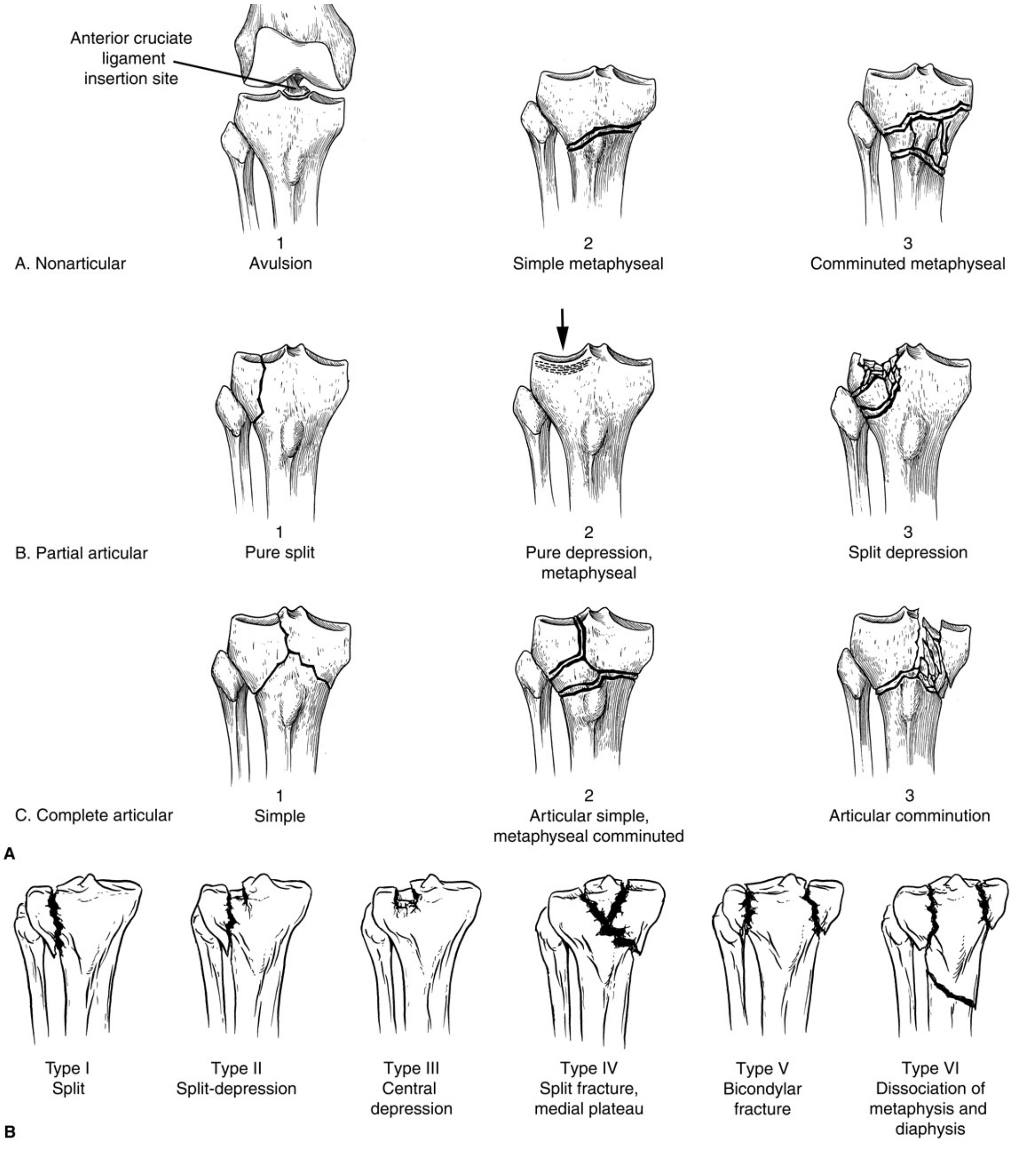


Fig no. 17. Schatzker classification for tibial plateau fractures

6) GUSTILO - ANDERSON CLASSIFICATION-OPEN INJURIES[39]

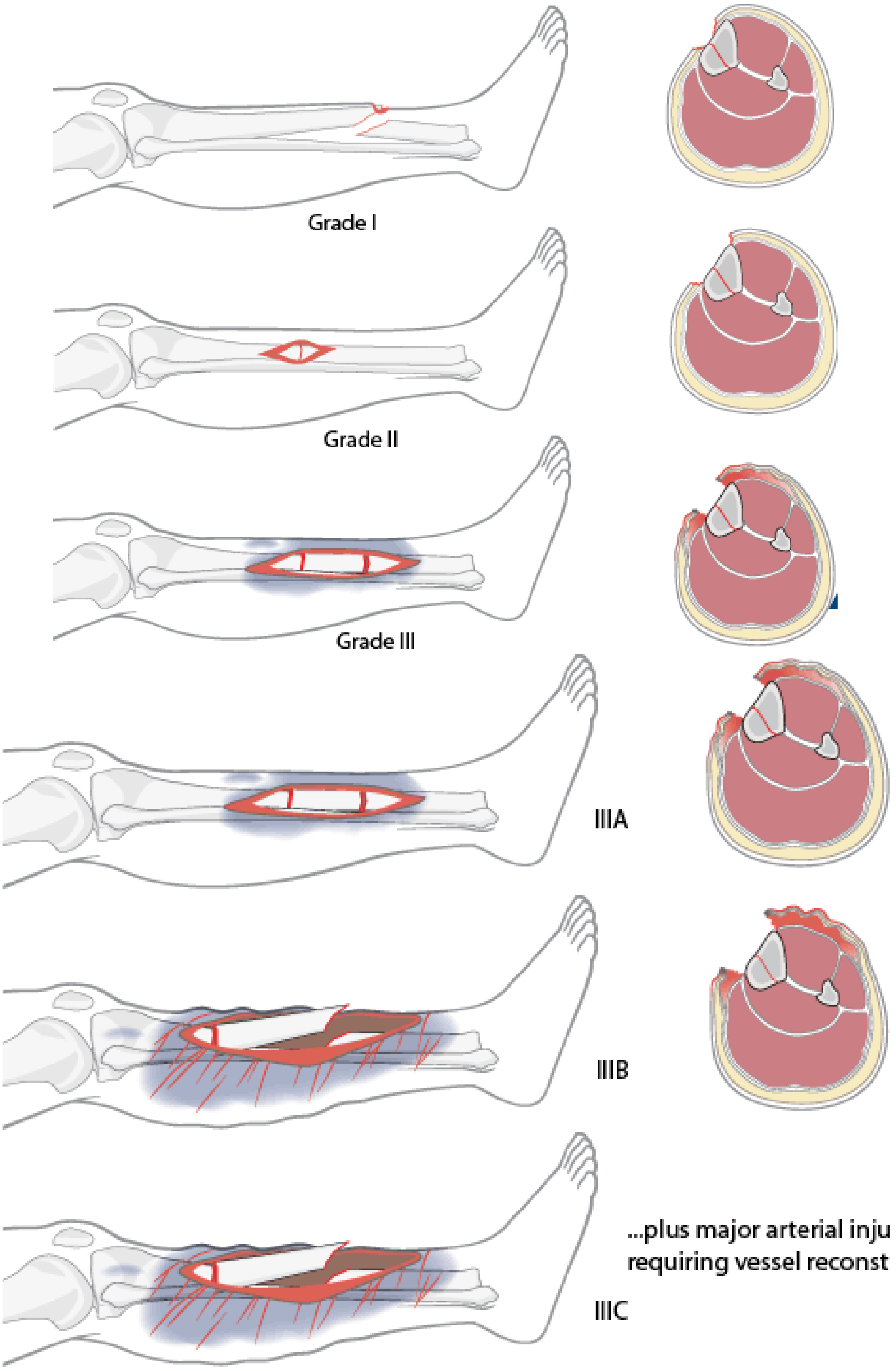
Type	Description
I	Skin wound less than 1 cm
	Clean
	Simple fracture pattern
II	Skin wound more than 1 cm
	Soft-tissue damage not extensive
	No flaps or avulsions
	Simple fracture pattern
III	High-energy injury involving extensive soft-tissue damage
	Or multifragmentary fracture, segmental fractures, or bone loss irrespective of the size of skin wound
	Or severe crush injuries
	Or vascular injury requiring repair
	Or severe contamination including farmyard injuries

Gustilo and Anderson classification of open fractures

Type	Description
IIIA	Adequate soft-tissue cover of bone despite extensive soft-tissue damage
IIIB	Extensive soft-tissue injury with periosteal stripping and bone exposure
	Major wound contamination
IIIC	Open fracture with arterial injury requiring repair

Gustilo classification of type III open fractures

Fig no. 18 . Gustilo - Anderson classification



Materials and Methods

MATERIALS AND METHODS

Purpose of the study:

1) To analyse the functional outcome following fixation in floating knee injuries using Karlstrom criteria
2) To study the influence of associated injuries in deciding the timing of definitive fixation and the outcome.

Data collection and methods: collection of data as per the proforma with consent from the patients admitted in the Orthopaedic department, Govt.Royapettah hospital , Kilpauk medical college , Chennai.

Inclusion criteria:

1) Patients in the age group of above 18 years
2) Both male and female patients
3) Patients with ipsilateral fractures of femur and tibia
4) Closed and compound floating knee injuries
5) Floating knee injury patients with other associated injuries

Exclusion criteria:

1) Age less than 18 years
2) Pathological fractures
3) Associated neuro- vascular damage of the affected limb

Methodology:

All the trauma victims received in the casualty will be immediately started on ATLS protocol giving due importance to their Airway, Breathing and Circulation. Serial monitoring of the blood pressure, pulse rate and oxygen saturation (SpO2) done in the emergency room. Once the patient is hemodynamically stabilised, thorough search for any life threatening injuries done in the casualty.

Stable patients were shifted to radiographs and appropriate X-rays taken . X-rays were taken to image the entire femur and tibia with the adjacent articulations of the knee, hip and ankle. Those patients diagnosed of having floating knee injuries were immediately splinted with Thomas splint/Plaster of paris. Basic investigations like complete hemogram , RFT , Chest X-ray , ECG were done . Depending upon the hemodynamic status , arrangements for blood transfusion made.

Any compound injury were initially managed by giving thorough wound debridement in the emergency theatre . Depending upon the wound status and contamination , external fixators were applied in required patients. Appropriate antibiotics and prophylactic tetanus toxoid were started.

In patients undergoing external fixator as the emergency procedure were converted to definitive fixation once the wound got healed and the infection being effectively managed and soft tissue cover given.

In polytrauma patients with floating knee injury, after an initial resuscitative phase patients were categorised into

1) Stable
2) Borderline
3) Unstable
4) In extremis

1) In all the stable patients and borderline patients who become stable after resuscitation were classified according to the modified Fraser classication for floating knee injuries and their extremities splinted and planned for definitive management.
2) In all unstable patients , in extremis patients and borderline patients who become unstable, life threatening injuries managed immediately and Damage Control Orthopaedics opted in these patients with subsequent ICU care till they become stable.

The plan of management for the given patient was made depending on the nature of fracture, location of fracture and the associated injuries.

After definitive management of these injuries , the patient was subjected to mobilization schedule according to associated injuries and general condition. Serial follow up X-rays were taken at 4 weeks, 6weeks, 3months, 6months and 1 year and looked for bony union and functional outcome analysed using the Karlstrom and Olerud criteria.

Total of thirty patients were included in the study. Out of them two patients lost follow up and one patient died during the course of the study and they were excluded from the study.

Final study comprises of 27 patients with floating knee injuries who were classified according to the Modified Fraser classification.

All the stable patients and polytrauma patients undergoing emergency procedures and Damage control Orthopaedics were analysed with standard parameters as follows and taken up for definitive fixation once they satisfy all the criteria as follows,

- STABLE HEMODYNAMICS (systolic B.P. > 100 mm Hg diastolic B.P>70mmHg)
- STABLE OXYGEN SATURATION AT ROOM TEMPERATURE (Spo2 92%)
- TEMPERATURE SHOULD NOT BE LESS THAN 32 degree C
- NO REQUIREMENT OF INOTROPHIC SUPPORT
- URINE OUTPUT - > 1 ml /Kg/hr

- ❖ REQUIREMENT OF FLUIDS (should not exceed 3L OR 5 UNITS OF BLOOD/24 hrs period)
- ❖ NO COAGULATION DISTURBANCES (NORMAL BT/CT/Platelet count> 1 lakh /cu.mm)
- ❖ SERUM LACTATE LEVEL (LESS THAN 2.5 mg/dl)

In patients with compound injury undergoing initial debridement and external fixators, were given adequate soft tissue cover after the infection got controlled and definitive fixation done.

IMPLANTS USED:

EXTERNAL FIXATORS AND KNEE SPANING CONSTRUCT

Fig no.19

Fig no.20

External fixator is a temporary and emergency stabilisation device for compound injuries and also a valuable tool in Damage control Orthopaedics. In our study emergency external fixation was done in 6 cases out of 27 cases. Isolated femoral side exfix was applied in 1 case and isolated tibial side exfix was applied in 2 cases. In rest of the three cases knee spanning construct was made. Two of the patient who has been treated with knee spanning exfix belong to polytrauma category.

The basic construct of an exfix which we used consisted of the following implants :

1) AO rod
2) AO clamp
3) Tube to tube clamp
4) 4.5 mm Schanz pin
5) 5.5 mm Schanz pin – for femur and metaphyseal region.

In all our cases with open injury , initial meticulous debridement was done in emergency theatre under anaesthesia followed by thorough wound wash which was followed by external fixator application in a sequential manner. Saline dressing was done daily in these patients and plastic cover given. Only then these patients were given definitive fixation in the form of nailing or plating.

FEMUR NAIL- IMPLANT AND PATIENT POSITIONING

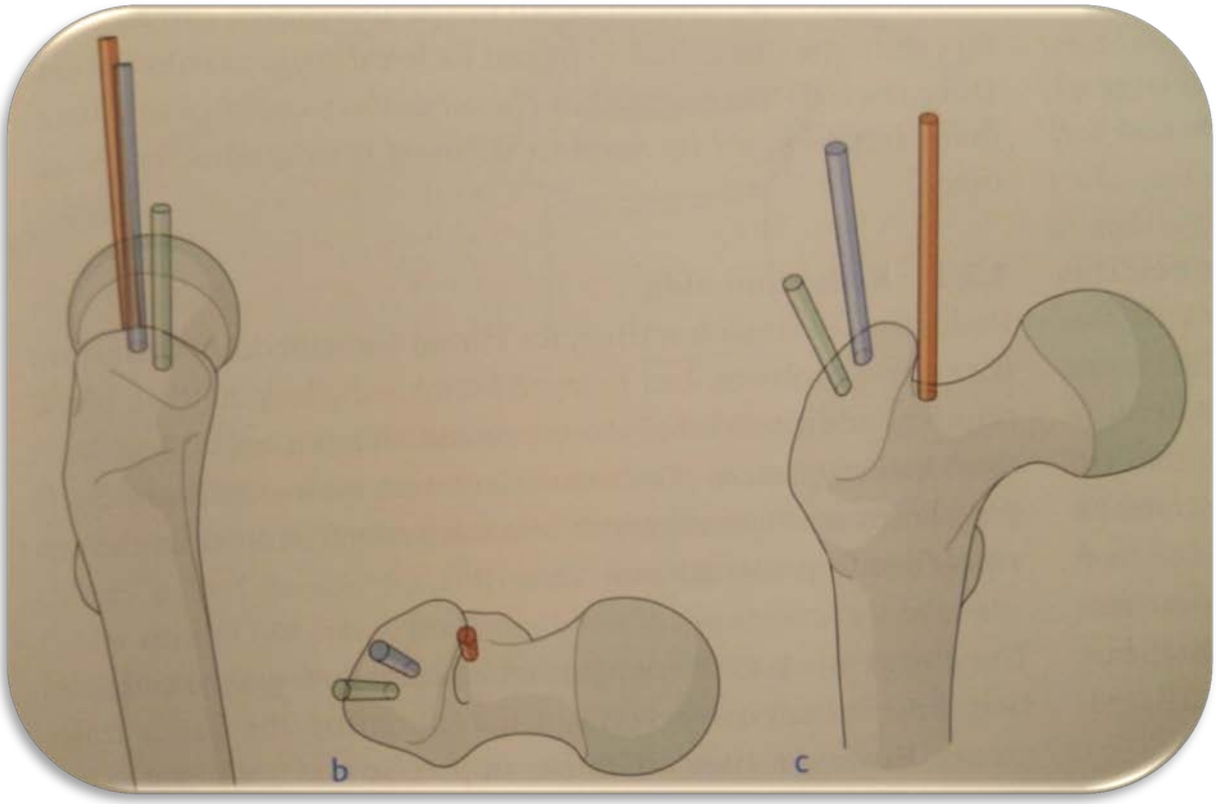
Fig no.21. femur nail

In our study , majority of case falls into Type I Fraser category and among the 21 cases of shaft fractures, femur nailing was applied in 20 cases and one of the case being managed by femur external fixator alone.

Closed nailing was done with the patient in supine position in fracture table and open nailing was done with patient in lateral position.

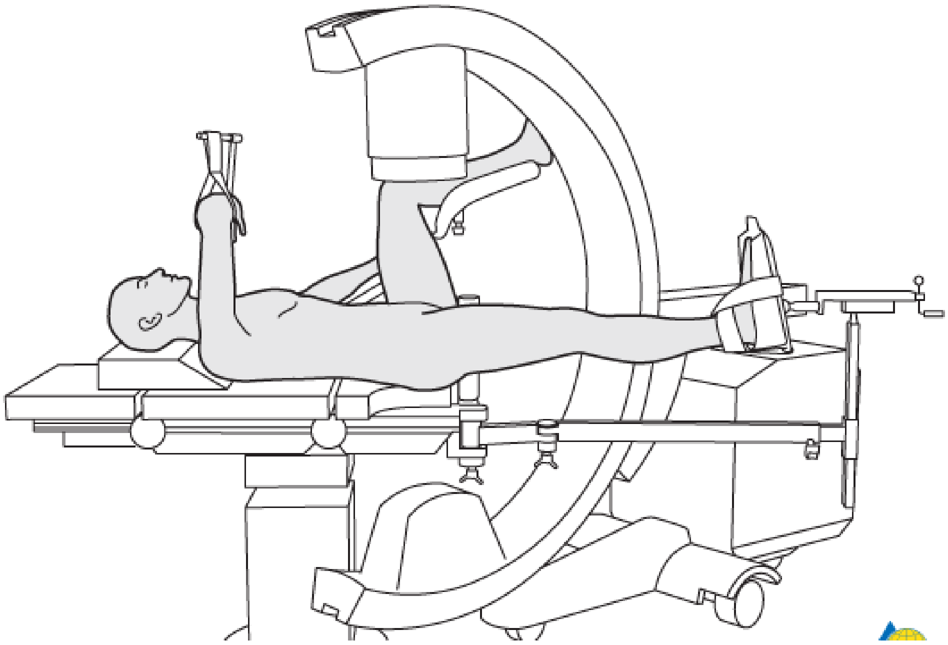
Femur nail is an intra- medullary implant available in varying sizes from 9 mm diameter to 12 diameter and of varying length. Is has got an anterolateral angulation to fit exactly the anterolateral bowing of normal femur. It has got two proximal and two distal locking options.

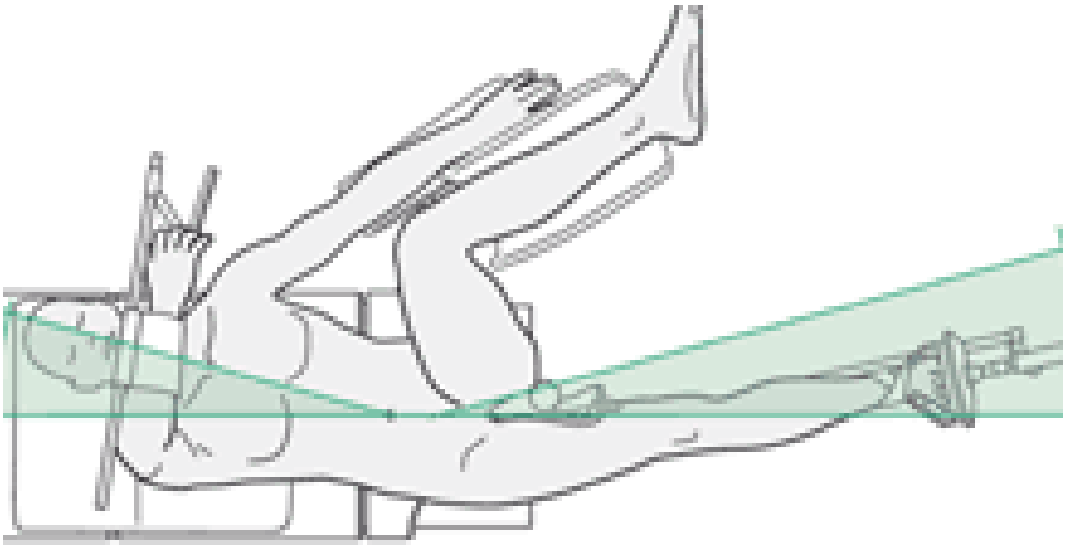
Various entry points for femur nail – fig no.22



We commonly used trochanteric entry point for shaft fractures (blue line in the picture) and more medial entry points (red line) are required in cases with proximal shaft and sub-trochantric fractures. Entry point was made after confirming the position of awl in both AP and lateral views under C-arm guidance.

Patient positioning for closed femur nailing in fracture table-fig no 23 & fig no 24





Patient was positioned in a manner such that the un-affected limb was in lithotomy position and the affected limb was positioned with slight adduction to aid in reaming.

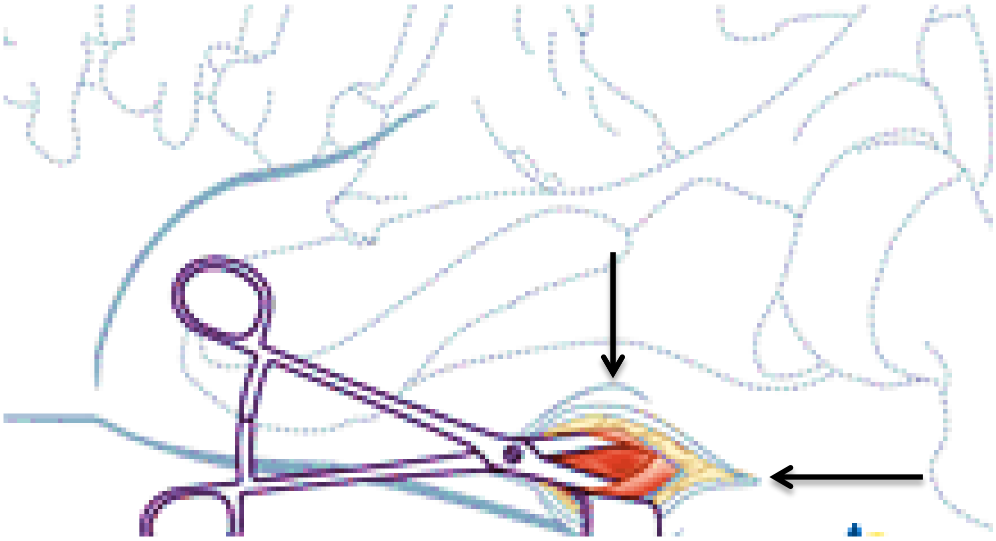


Fig no .25-incision for making entry point- femur nail

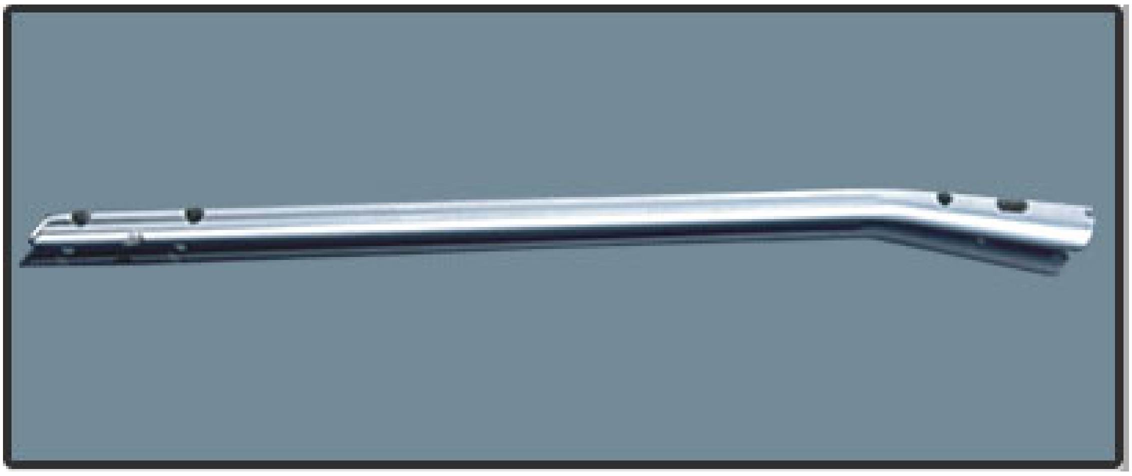
Incision made 3 cm proximal to the trochanteric tip and anterior superior iliac spine can also used as a reference point .

Lateral positioning of the patient for open femur nailing –fig.no.26:

Through lateral approach for femoral shaft, skin incision made and iliotibial band split longitudinally and vastus lateralis split along its fibres to reach the fracture site.

TIBIA NAIL – IMPLANT AND PATIENT POSITIONING

Fig.no.27

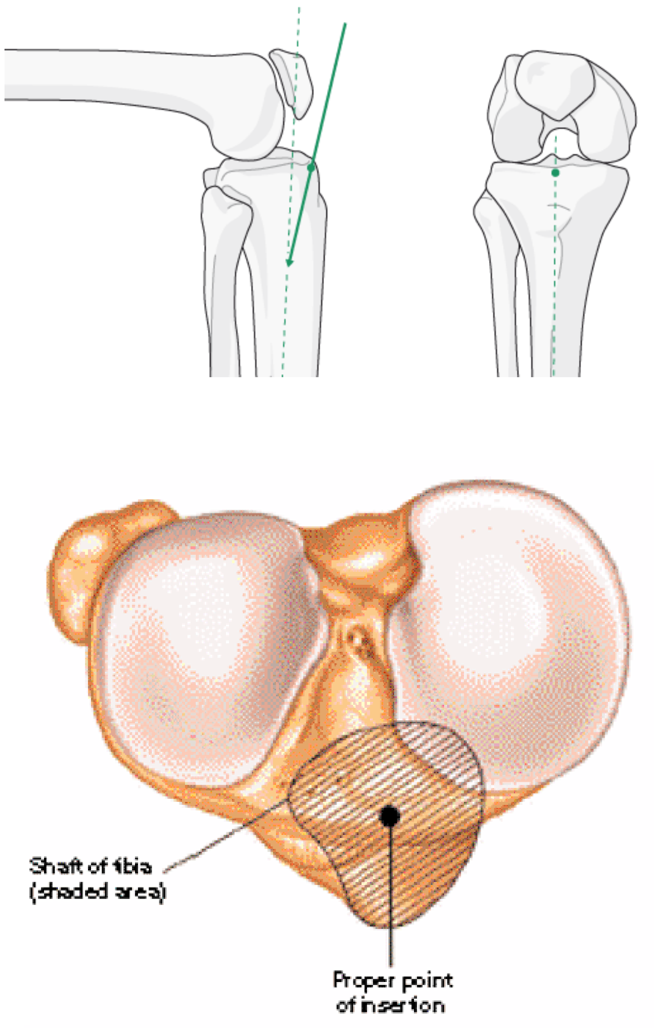


In our study majority of tibial side fractures belong to the shaft category – type I Fraser classification (17 cases). All these fractures are managed with this intramedullary implant.

Available in varying sizes from 8 mm to 12 mm diameter, it has a typical bend in its proximal aspect to accommodate the anatomical curve of proximal tibia. This is known as Herzog's bend and is normally of 11 degrees. Has 2 proximal locking (1 dynamic mode and 1 static mode) and three distal locking (2 – mediolateral and 1 – AP locking). One of the recent advances is the expert tibia nailing with varying locking options – suitable for shaft fractures that are too proximal and too distal.

Making a perfect entry point is essential for the correct insertion of guide wire and reamers. After guide wire insertion into both proximal and distal segments, serial reaming done with progressive reamers and proximal reaming done. Finally the nail inserted which is usually one size smaller than the reamer used.

Fig no.28 & 29 – tibia nail – entry point



Proper point of entry for tibia nail is 1 – 1.5 cm distal to the joint line just medial to the lateral tibial eminence. In cases where tibia is fixed first prior to femur , we used the leg hanging technique to aid in reduction and reaming.

DISTAL FEMUR LOCKING PLATE –fig.no-30:

In our study we encountered 6 cases of supracondylar fracture femur and all of them have been fixed with distal femur locking compression plate. Available in various sizes from 4 to 16 holed and side specificity, it has given a stable mode of fixation which allowed us to start early functional mobilisation in these patients which is of prime importance in floating knee injury patients. The plate consists of three parts :

1) Plate head – cancellous locking screws and option for provisional ‘k’ wire fixation
2) Plate neck
3) Plate shaft – consist of combi holes (both locking+DCP holes)

PROXIMAL TIBIA LOCKING PLATE

Medial side –fig.no:31

Out of 8 cases of proximal tibial fractures in our study (Schatzkar type + proximal shaft where nailing was not possible) , we used proximal tibia locking compression plate in 6 cases. Patients with bicondylar fracture were applied bicondylar plating with specific LCP’s used for medial and lateral aspects.

In patients with type V and VI Schatzkar medial plateau has been fixed first followed by lateral side as the medial plateau bears much of the weight.

LCP – lateral side-fig.no-32

We have not used MIPPO technique in our study. Open plating was done in all the patients and double incision was used in case of bicondylar fractures. These LCP's are side specific and effective in stabilising severely comminuted fractures of proximal tibia thus allowing early knee mobilisation in these patients.

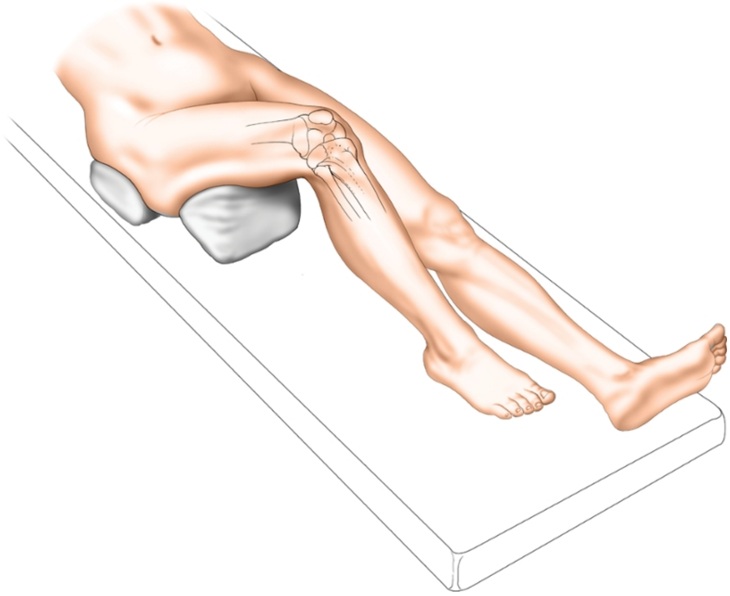
BUTTRESS PLATE – L AND T BUTTRESS PLATE FOR PROXIMAL TIBIA-fig.no-33

Two out of 8 proximal tibial fractures have been managed with buttress plating, though buttress plating was a less stable fixation than LCP.

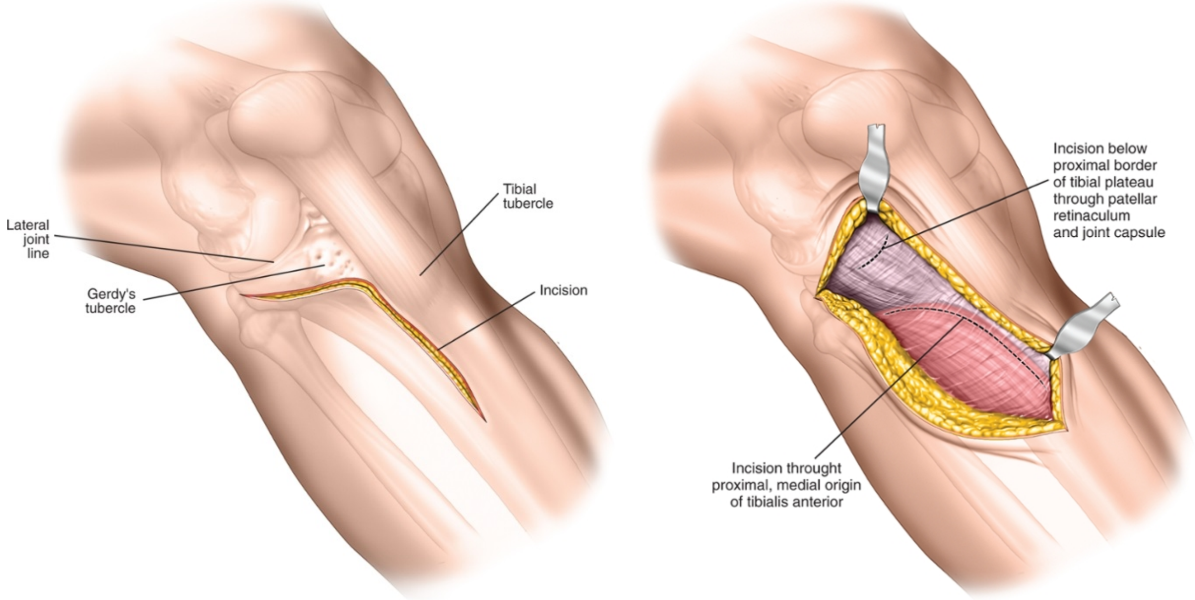
Surgical approaches used for proximal tibia :

Lateral tibial plateau – anterolateral approach is used . 'S' shaped incision made 3-5 cm proximal to the joint line and is curved around the Gerdy's tubercle and extended distally just lateral to the tibial shin. Erase the attachment of tibialis anterior from the proximal tibia and visualise the fracture site.

Patient positioning for lateral tibial plateau fixation-fig.no 34



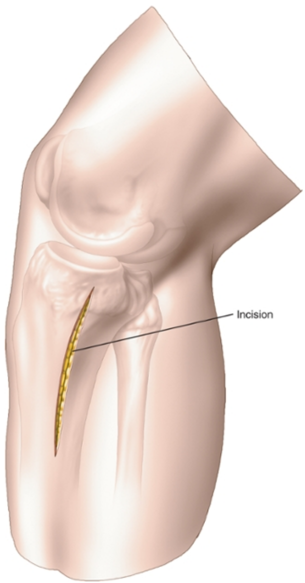
Skin incision-fig.no.35



Patient positioning for medial plateau fixation.fig.no.36

Sand bag kept under contralateral hip to aid in external rotation of injured limb.

Incision and exposure.fig.no.37



Incision was made over the postero-medial aspect of proximal tibia. Incision deepened, pes anserinus incised or retracted posteriorly. Incision deepened between pes anserinus and medial head of gastrocnemius and the fracture site reached.

Observation and analysis

Age and sex distribution: chart no .1

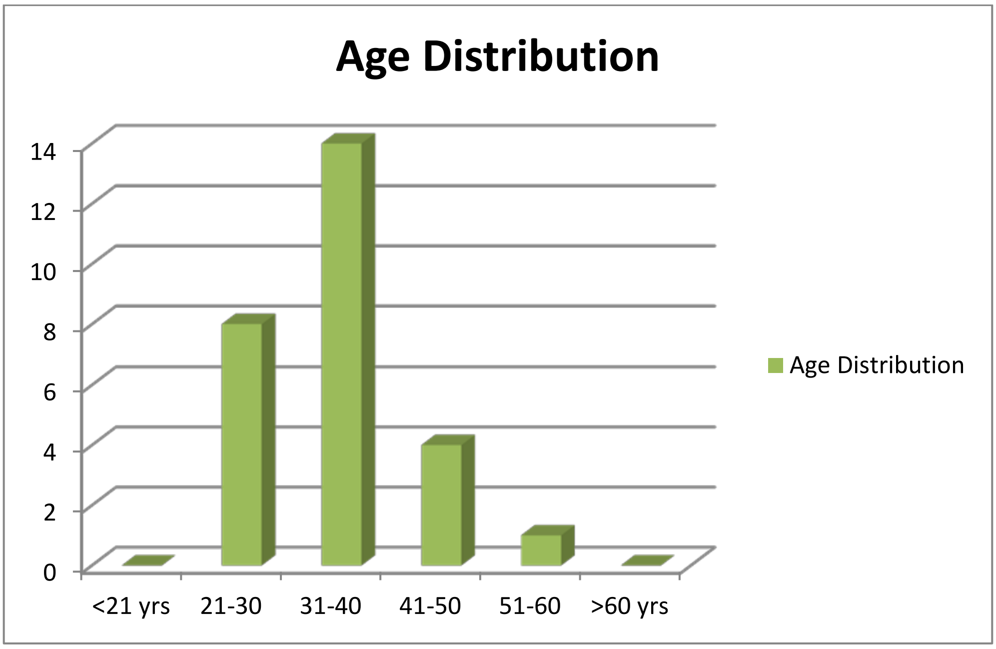
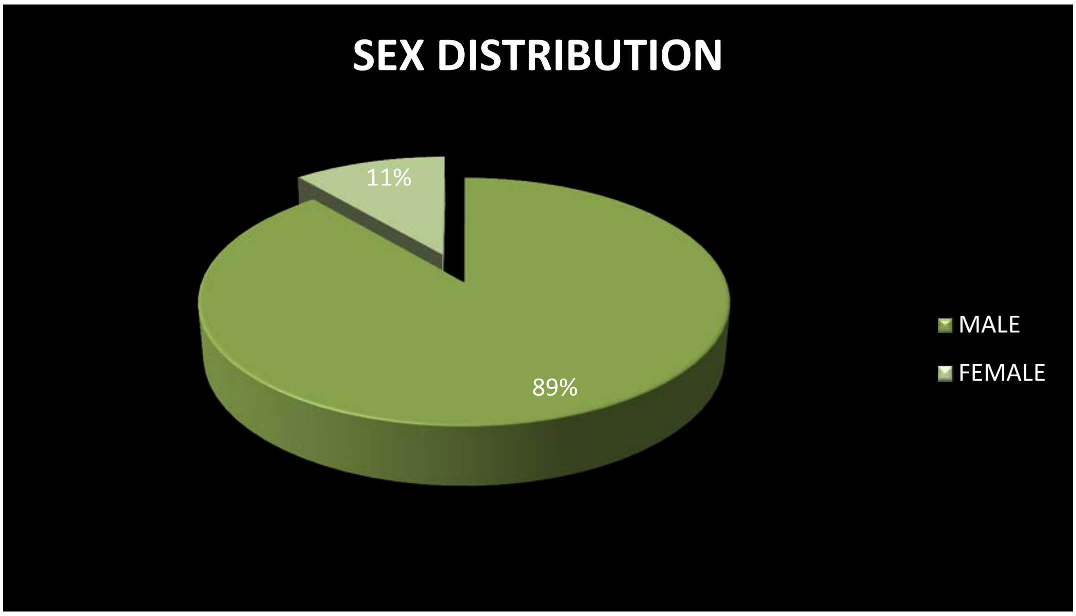


Chart no .2



The study comprises of patients in the age group between 21 and 60 yrs, majority of patients in the age group between 31 to 40 years representing the working group of population .

Majority of the patients in the study were male patients majority of whom were the sole bread winner of the family.

Table no.1 .Age and sex distribution

S.NO	AGE	MALE	FEMALE	TOTAL	PERCENTAGE
1	<20 YRS	0	0	0	0
2	21-30 YRS	8	0	8	29.63%
3	31-40 YRS	12	2	14	51.85%
4	41-50 YRS	3	1	4	14.81%
5	51-60 YRS	1	0	1	3.70%
6	>60 YRS	0	0	0	0
TOTAL				27	100 %

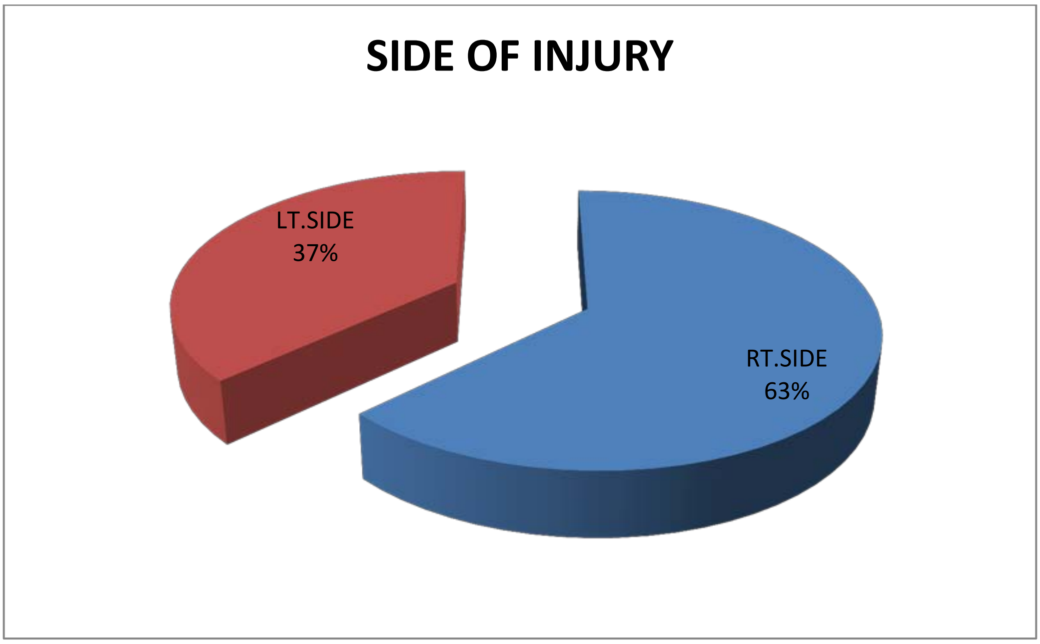
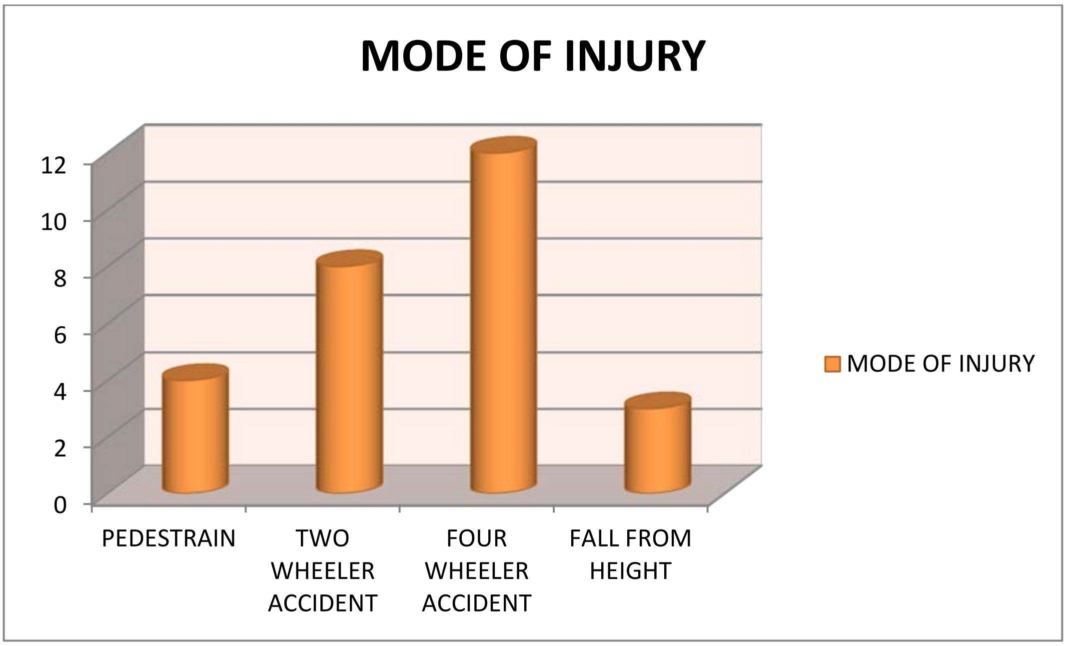


Chart no.3

In our study of 27 patients, 17 patients had injuries on their right side (63%) and 10 patients had left sided injury. (37%)

Mode of injury: Chart no.4



In our study we had 12 patients who sustained injury due to high velocity trauma with four wheeler collision. 8 patients sustained injury due to two wheeler accidents and 3 patients due to fall from height. Four patients were injured due to hit by a two wheeler or four wheeler in which the patient was a pedestrian.

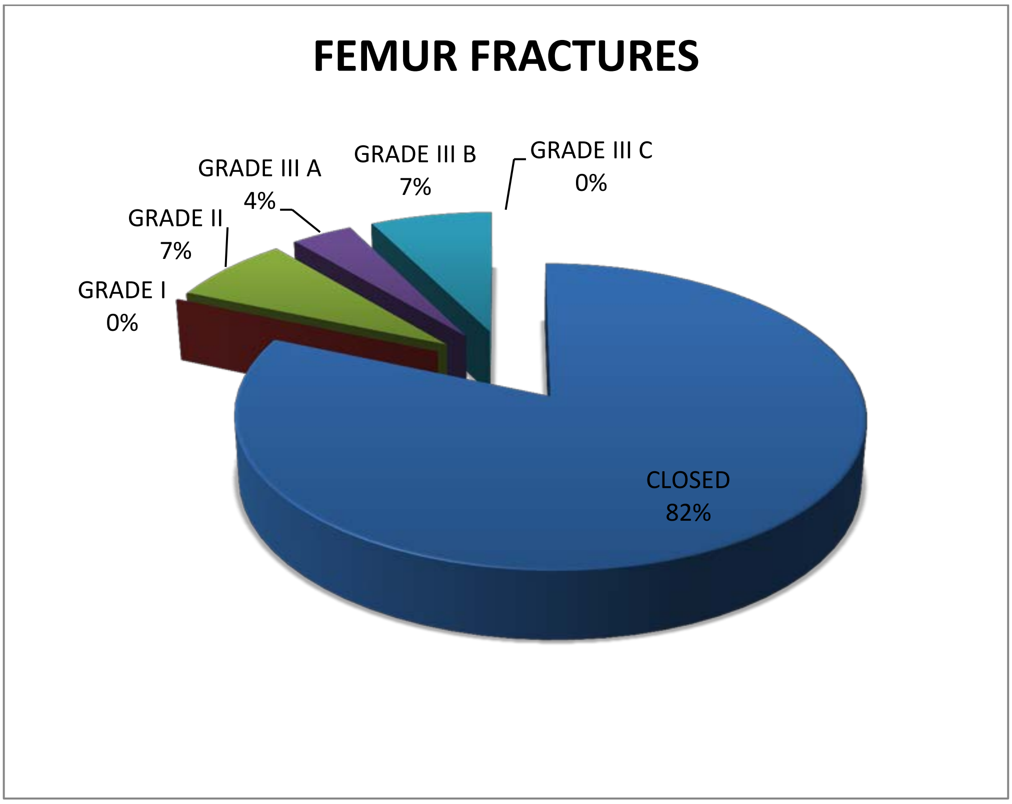
Table no.2. DISTRIBUTION OF TYPES OF FRACTURE:

TYPES	FEMUR	TIBIA
CLOSED	22	16
COMPOUND	5	11
TOTAL	27	27

Out of 27 cases considered in the study, 12 cases had compounding. Compound injuries more commonly associated with tibial fracture in our study. These injuries range from grade 1 compound to grade 3B injuries. We have not encountered grade 3C compound injuries in our study. (based on Gustilo-Anderson classification)

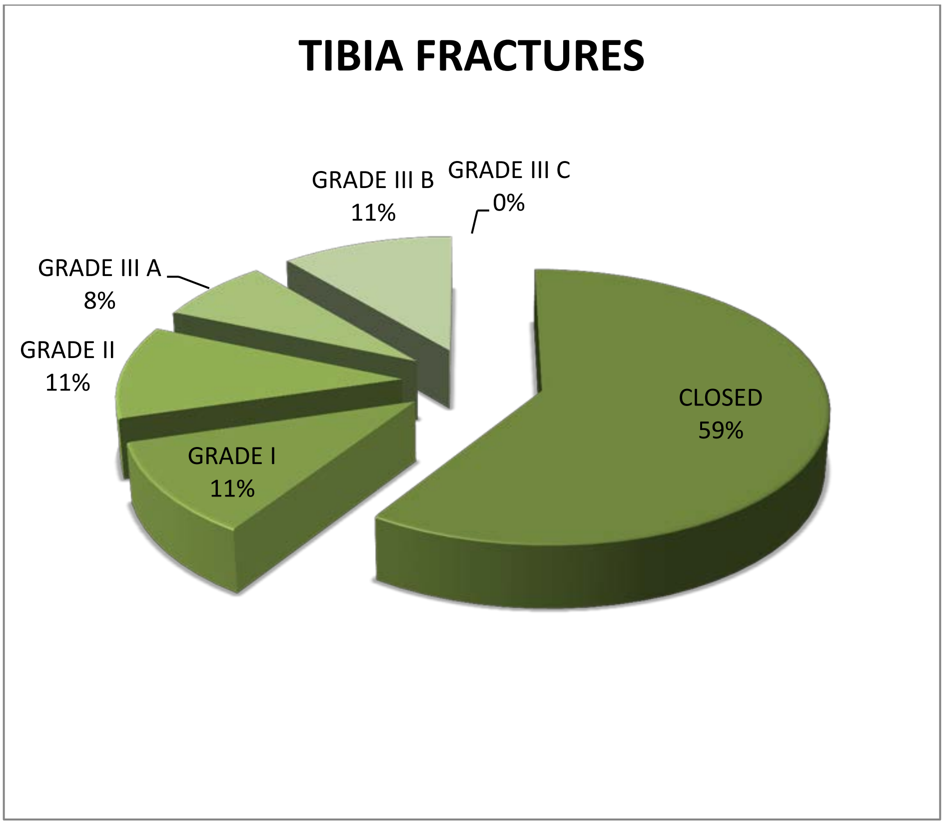
Out of 27 femur fractures 5 cases were compound injuries and out of 27 cases of tibia 11 cases were compound injuries.

Distribution of femur fractures: Chart no.5



Out of 27 femur fractures, 5 cases were compound injuries (18%). Among these we had two cases of grade 2 compound fractures, one case of grade 3 A compound fracture and two cases of grade 3 B compound fracture.

Distribution of tibia fracture : Chart no.6

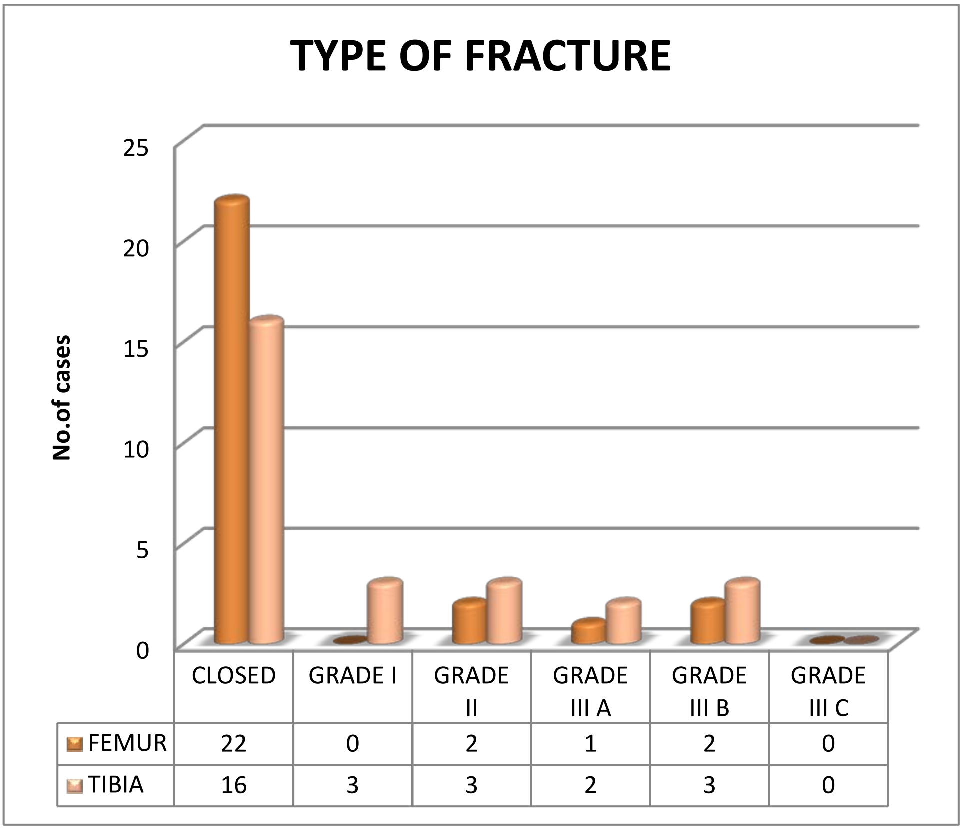


Out of 27 tibial fractures , 11 were compound injuries accounting for nearly 41% of tibial fractures in contrast to femur fractures in which only 18% were compound injuries. Out of the 11 compound injuries, 3 were grade 1 compound injury, 3 were grade 2 compound injury, 2 were grade 3A compound injury and 3 were grade 3B compound injury.

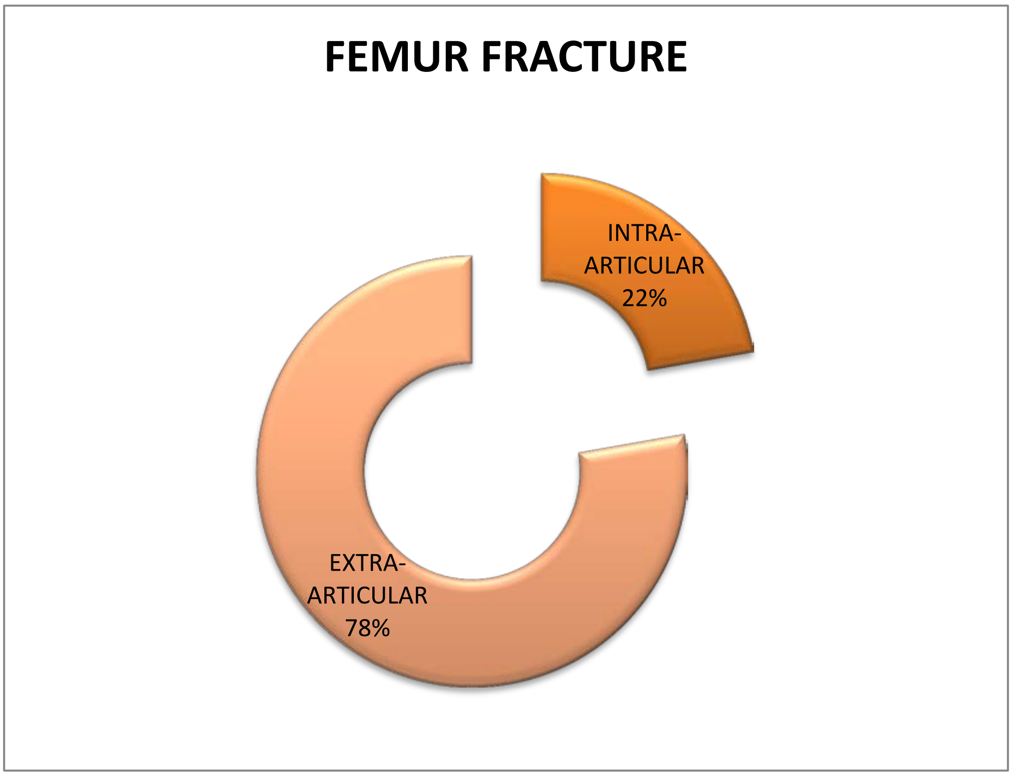
Table no. 3. Type of Open fractures (Gustilo-Anderson classification)

GRADE	FEMUR	TIBIA	TOTAL	PERCENTAGE
GRADE I	0	3	3	18.75%
GRADE II	2	3	5	31.25%
GRADE IIIA	1	2	3	18.75%
GRADE IIIB	2	3	5	31.25%
GRADE IIIC	0	0	0	0
TOTAL	5	11	16	100%

Chart no.7

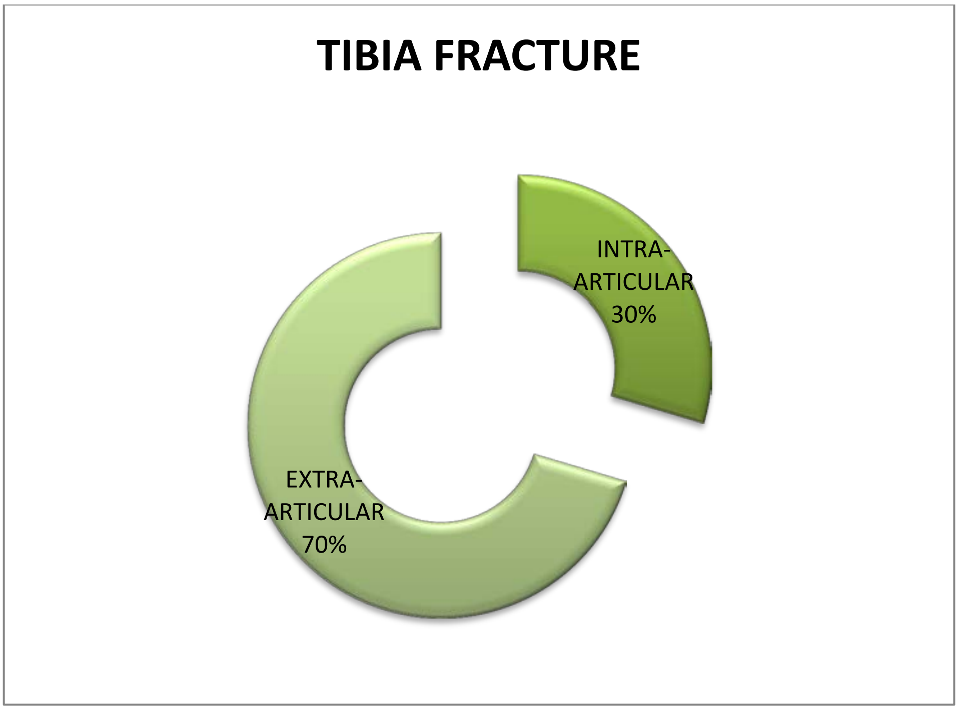


FEMUR FRACTURE – INTRA-ARTICULAR AND EXTRA-ARTICULAR DISTRIBUTION-Chart no.8



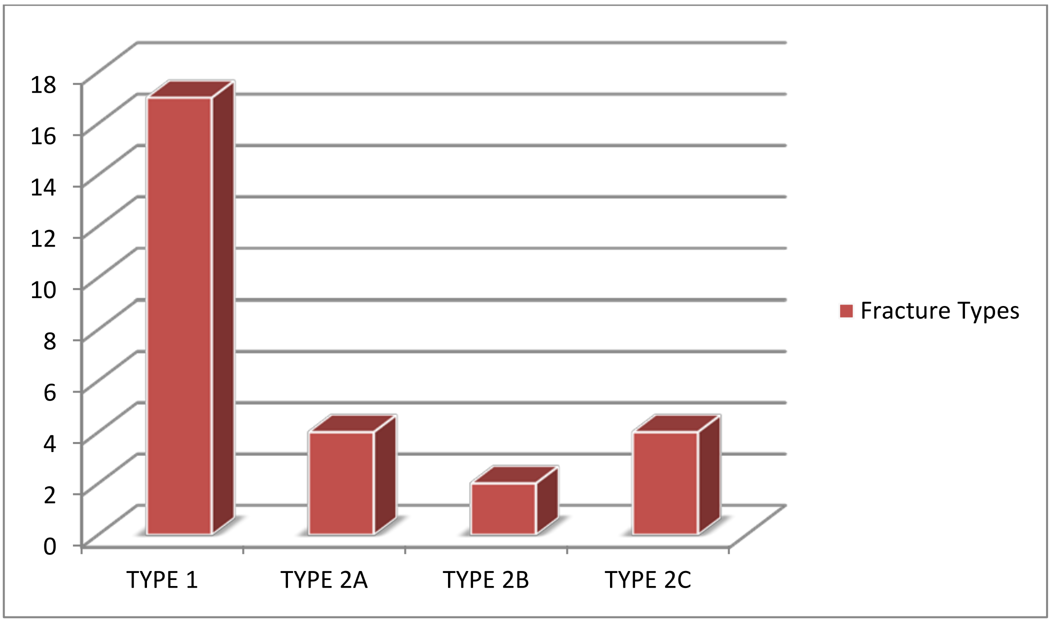
Among 27 femur fractures , 6 were intra-articular fractures(22%) and 21 were extra-articular fractures (78%). All these intra-articular fractures were confined to the knee joint.

TIBIA FRACTURES – INTRA-ARTICULAR AND EXTRA-ARTICULAR DISTRIBUTION-Chart no.9



Among 27 tibial fractures , 8 cases were intra-articular fractures accounting for 30% of tibia fractures. 19 cases were extra-articular fractures (70%). Out of 19 tibial diaphyseal fracture, 2 cases were segmental tibial shaft fractures.

MODIFIED FRASER CLASSIFICATION OF CASES- Chart no.10



Out of 27 cases 17 cases were grouped under type 1 floating knee injury with both shaft fractures.

4 cases were grouped under type 2A with tibial side being intra-articular and femoral side being the shaft fracture.

2 cases were grouped under type 2B with femoral side being intra-articular and tibial side being shaft fracture.

4 cases were grouped under type 2C in which both the femoral and tibial fractures being intra-articular.

Table no.4. COMBINATION OF FRACTURES:

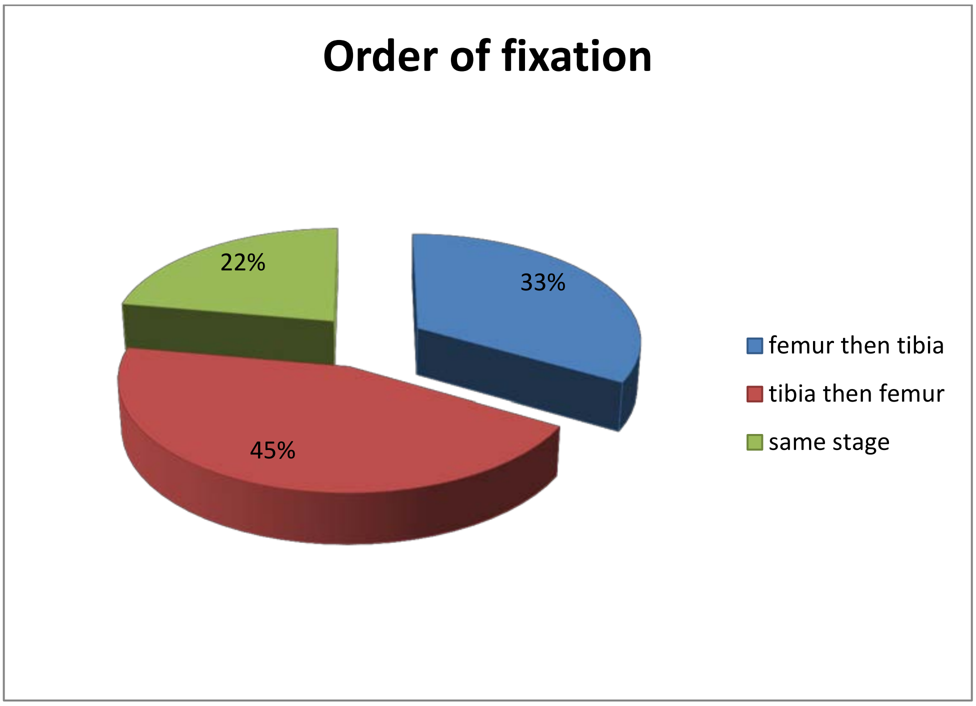
S.no	Fracture combination	Numbers
1	Both femur and tibia closed	14
2	Femur – grade I compound Tibia - closed	0
3	Femur – grade II compound Tibia - closed	1
4	Femur – grade III A compound Tibia - closed	1
5	Femur – grade III B compound Tibia - closed	1
6	Femur closed Tibia – grade I compound	3
7	Femur closed Tibia – grade II compound	2
8	Femur – closed Tibia – grade III A compound	1
9	Femur – closed Tibia – grade III B compound	2
10	Grade III C compound injuries	0
11	Both femur and tibia compound injuries (femur – grade II, tibia – grade III B) - 1 (femur – grade III A, tibia – grade III B) - 1	2
	TOTAL	**27**

Table no.5. Polytrauma cases :

Among 27 cases of floating knee injuries, three of the cases were polytrauma patients with other system involvement.

s.no	Age	Sex	Fractures	Other system involvement	Management
1	30	Male	**Type II A Fraser injury – Rt side.** Femur – diaphyseal- grade II comp. Tibia – intra-articular – grade III A comp.	Multiple rib fractures with hemothorax – Right side	Emergency ICD insertion and emergency Knee spanning exfix – Rt side.
2	46	Male	**Type II C Fraser injury – Rt side.** Femur- intra-articular- grade III B comp. Tibia – intra-articular – grade IIIB comp.	9,10,11 rib fracture –Lt side with splenic injury	Emergency exploratory laparotomy, partial splenectomy and knee spanning exfix –Rt side
3	38	Male	**Type I Fraser injury – Lt side** Femur – diaphyseal Tibia- diaphyseal – grade I comp. with # **shaft of femur contralateral limb.**	ARDS	IMCU management for ARDS. Floating knee injury – same stage nailing for both femur and tibia –day 2. Contralateral femur nailing – day 7.

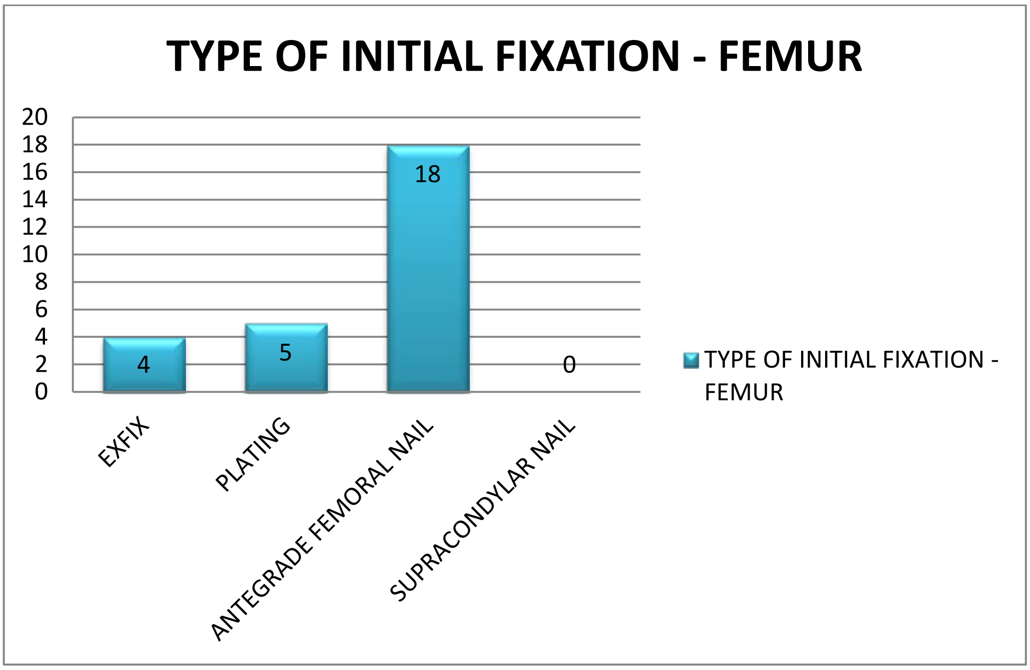
ORDER OF FIXATION – Chart no.11



The order of fixation in our study was based on the fracture type and patient's hemodynamic status.

In 12 (45%) out of 27 cases tibia was fixed first followed by femur and in 9 cases (33%) femur was fixed definitively first followed by tibia. In 6 patients (22%) both tibia and femur fractures were fixed simultaneously in the same sitting.

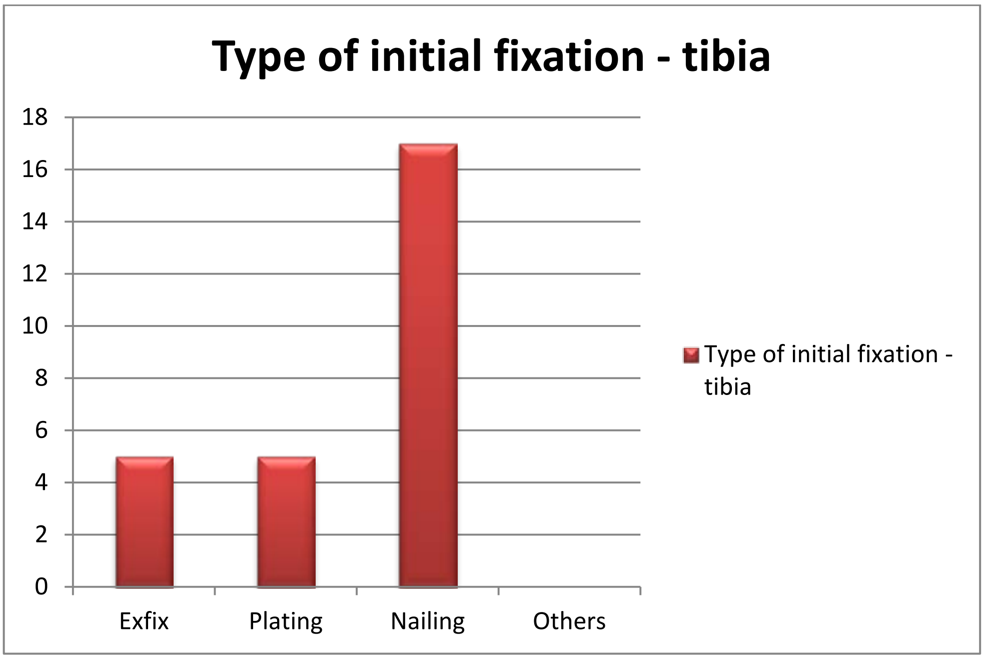
TYPE OF INITIAL FIXATION – FEMUR-Chart no.12



Among 27 femur cases , 18 cases were initially managed with femur nailing and 6 cases with plating. 4 cases required external fixator application.

In the external fixation category, knee spanning external fixation applied for 3 cases and isolated femur exfix applied for a single case with compound diaphyseal injury on femoral side alone.

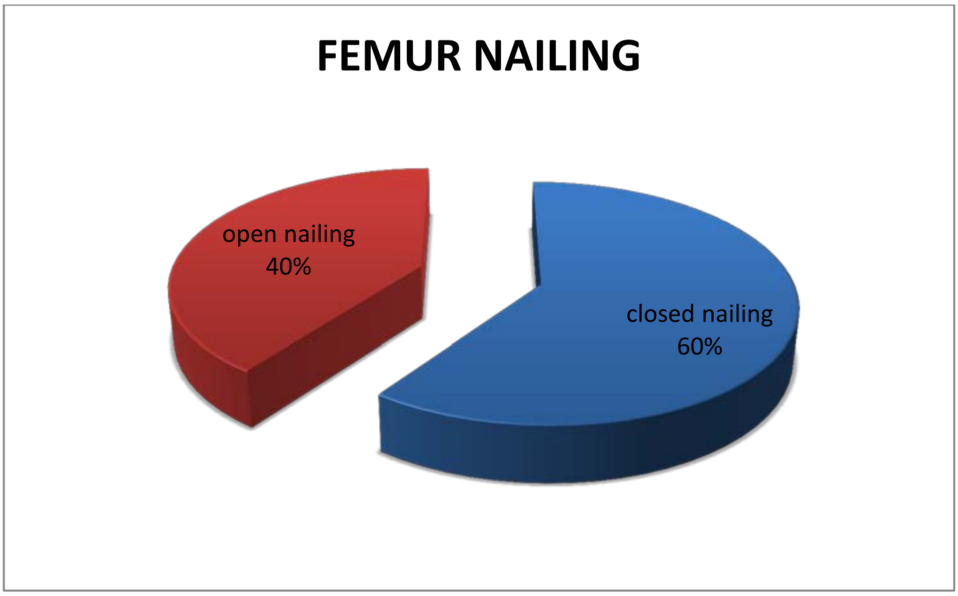
TYPE OF INITIAL FIXATION – TIBIA-Chart no.13



Among 27 tibia cases, 5 cases were managed initially with external fixators, 5 cases with plating and 17 cases with intra-medullary nailing.

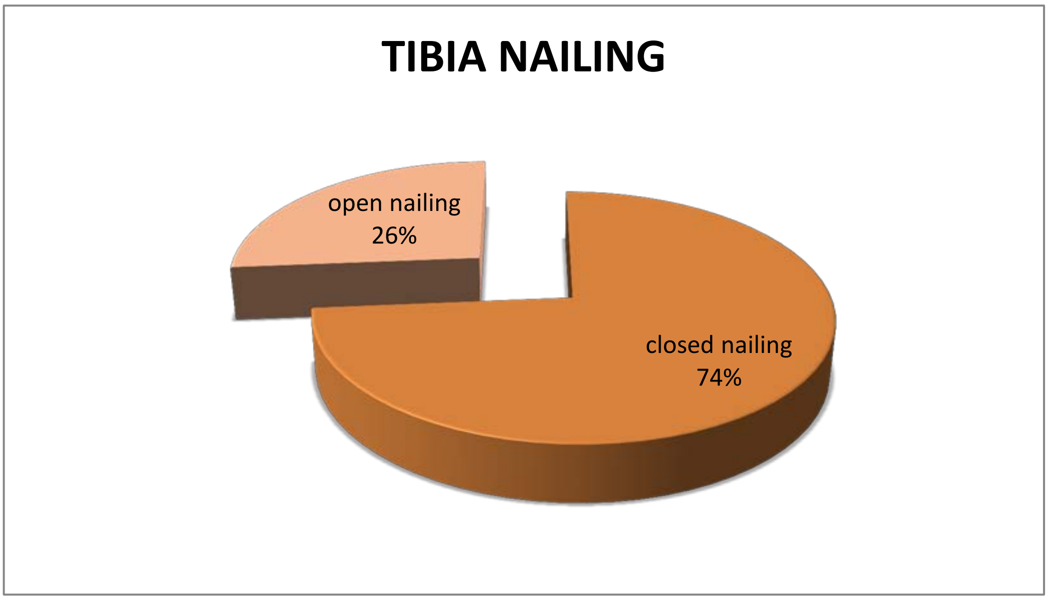
In the external fixation category, knee spanning exfix applied in 3 cases and rest of the two cases were applied with isolated tibial side exfix for compound injuries involving diaphyseal aspect of tibia alone.

OPEN Vs. CLOSED NAILING - FEMUR –Chart no 14



Out of 20 femur nailing done for shaft fractures, only in cases where tibia has been fixed prior has been positioned in fracture table for closed femur nailing (12 cases - 60%). In rest of the cases (8 cases - 40%) open femur nailing has been done with patient in lateral position. In patients with external fixators, secondary procedure of definitive internal fixation was done by open means after soft tissue management and devoid of infection.

OPEN Vs. CLOSED NAILING –TIBIA-Chart.no.15



Out of 19 cases of tibia nailing done for shaft fractures, closed reduction and nailing was done in 14 cases (74%). Even in patients who have not been fixed for femoral fracture were also given closed nailing by the method of hanging technique. In the rest of 5 cases (26%) , open nailing was done because of difficulty in achieving reduction by closed means and also in cases where external fixation was converted to definitive fixation after managing soft tissue injuries .

Table no. 6. Definitive fixation of both the fractures

S.no	Timing of fixation	Number of cases
1	Within 1 week of injury	21
2	1-2 weeks after injury	Nil
3	2-3 weeks after injury	5
4	>3 weeks after injury	1

After the patient has been initially stabilised and classified, definitive fixation was done in a staged manner depending upon the fracture type. In 21 cases both the femoral and tibial side fractures have been fixed within one week of injury, in 5 cases between 2 – 3 weeks of injury and in 1 case after 3 weeks of injury.

Table no. 7. ASSOCIATED FRACTURES:

S.no	Fracture	Number of cases	Management
1	**Contralateral Lower Limb:**		
	Contralateral femur fracture	1	Closed IMIL nailing
	Contralateral tibia fracture	1	Closed IMIL nailing
2	**Contralateral upper limb:**		
	Distal radius fracture	2	Ligamentotaxis using wrist spanning exfix
3	**Ipsilateral upper limb:**		
	# Both Bone Forearm	1	ORIF with PO
	Distal humerus fracture	1	ORIF with PO
	Metacarpal fracture 2nd,3rd	1	K wire fixation
	Clavicle fracture	2	Conservative – 1 ORIF with PO -1
4	**Ipsilateral lower limb:**		
	Patella fracture	3	Circlage wiring-2 Conservative - 1
	Calcaneal fracture	2	Conservative
	Bimalleolar fracture ankle	1	ORIF with PO for fibula CRIF with malleolar screw fixation for medial malleolus
	TOTAL	**15**	

Results and discussion

RESULTS AND DISCUSSION

Functional outcome of patients with floating knee injuries were measured following bony union. Factors which may influence bony union in these patients were, associated fractures and their management, intra-operative and post-operative complications.

ASSOCIATED FRACTURES AND THEIR MANAGEMENT:

Associated fractures of contralateral lower limb:

We had one patient with closed diaphyseal fracture of femur of contralateral limb and one patient with closed diaphyseal fracture of tibia of contralateral limb. Both the fractures were managed with closed intramedullary nailing in a staged manner along with the fixation of floating knee injury.

Associated fractures of contralateral upper limb:

Two patients out of 27 cases had distal radius fracture involving contralateral wrist and both of them were managed with ligamentotaxis using wrist spanning external fixator.

Associated fractures of ipsilateral upper limb:

One of our patient had both bone fracture forearm managed with plating. Comminuted inter-condylar fracture humerus was encountered in one of the patient managed with bicolumnar plating. One of the patient with metacarpal fracture was managed with closed k wire fixation . Among 2 patients with clavicle fracture one was managed conservatively and other with plating.

Associated fractures of ipsilateral lower limb:

Two patients with patella fracture were managed with circlage wiring. 2 patients with calcaneal fracture were managed conservatively. One of the patient with bimalleolar fracture ankle was managed with malleolar screw fixation for medial malleolus and plating for fibula.

Out of the three polytrauma cases described earlier , two cases were treated under the principles of Damage control Orthopaedics. Knee spanning external fixator applied in both the cases after stabilising the life threatening injury. One of the patient with ARDS was managed in IMCU and definitive staged fixation done for both the fractures after stabilising the hemodynamic status.

Lactate Level Measurement And Its Uses:

In patients with multiple long bone fractures and polytrauma as in our study, serum lactate level measurement was considered as one of the prognostic markers. Initial serum lactate levels were measured in all our patients during presentation to the emergency department and their levels documented. Definitive fixation in all our patients were done only when they satisfy the criteria which we mentioned earlier in materials and methods. Serum lactate level < 2.5 mg/dl was taken as the cut-off value and patients were opted for definitive fixation once their lactate values satisfy the above criteria. Even in staged fixation category, lactate levels were measured after the first procedure and looked for second hit phenomena. Serum lactate level > 2.5mg/dl was an indicator for ongoing hemodynamic compromise.

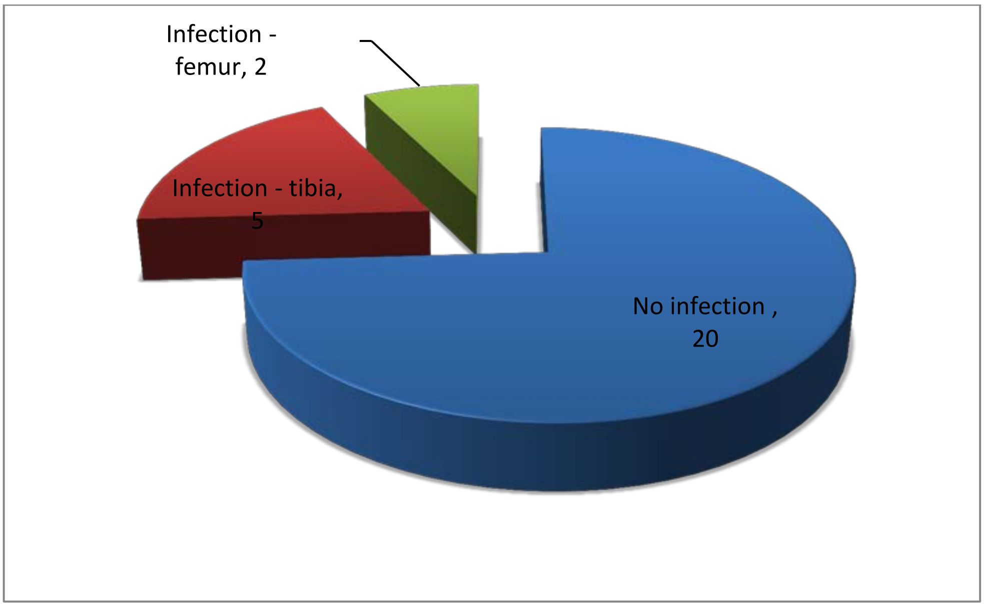
Table no. 8. POST OPERATIVE COMPLICATIONS:

S.no.	Complications	Number of cases		Total
		Femur	Tibia	
1	Infection	2	5	7
2	Delayed union	2	3	5
3	Non – union	0	1	1
4	Malunion	1	2	3
5	Shortening	4		4
6	Fat embolism	0		0
7	Deep venous thrombosis	0		0
	Total			20

In our study we had 7 cases with post operative infection , 5 cases with delayed union and 1 case with non-union tibia.

Malunion of fractures occurred in 3 patients and shortening in 4 patients. We have not encountered fat embolism and DVT in our study.

Post Operative infection: Chart. no.16



Out of seven cases with post operative infection, 2 cases of femur and three cases of tibia were managed with appropriate IV antibiotics. One of the case with tibial side infection required implant exit and another patient with tibial side infection required conversion to Ilizarov ring fixator.

Table no. 9. Delayed union:

S .no	Bone	Segment of the bone	Management
1	Femur	Diaphysis	Exchange nailing
2	Femur	Metaphysis	Bone grafting
3	Tibia	Diaphysis	Bone grafting
4	Tibia	Diaphysis	Dynamisation
5	Tibia	Diaphysis	Dynamisation

Out of 5 cases of delayed union , 2 cases were on femoral side and 3 cases were on tibial side.

For femoral side delayed union, one patient was managed with exchange nailing with bone grafting and one with bone grafting alone.

For tibial side delayed union, one patient was managed with bone grafting and two patients were managed with dynamisation at around six weeks.

Non union:

One of the patient in our study went in for infective non- union of tibial side diaphyseal fracture which was managed with removal of intramedullary implant and conversion to Ilizarov ring fixator application.

Malunion:

Malunion occurred in two metaphyseal fractures of tibia treated with plating and one metaphyseal fracture of femur treated with plating. no specific intervention was done in these patients.

Table no.10. Shortening :

S .no	Shortening	No.of cases	Management
1	<1cm	2	Nil
2	1-2.5 cm	2	Shoe raise
3	>2.5cm	Nil	Nil

Out of four patients with shortening of limb , two patients between 1-2.5 cm shortening were given shoe raise.

Table no.11.TIME TAKEN FOR BONY UNION - FEMUR :

S.no.	Time period	No.of patients	Percentage
1	< 4 weeks	0	0
2	4 weeks – 6 weeks	0	0
3	6 weeks – 3months	14	51.85%
4	3 months – 6 months	11	40.74%
5	6 months – 1 year	2	7.40%
6	>1 year	0	0
	Total	27	100%

Patients were followed up at regular intervals of 4 weeks and radiological union documented in all these patients. Radiological union was considered when three out of four cortices was found to show solid union in both AP and lateral views.

In femur fracture cases the average time for union which we found in our cases came around 3.3 months / 14 – 15 weeks. Union was delayed slightly in open nailing category and comminuted fractures. One of our case who has been applied femur exfix had union at around 6 months and another case in whom exchange nailing was done had union at around 8 months.

Table no.12. TIME TAKEN FOR BONY UNION – TIBIA :

S.no.	Time period	No.of cases	Percentage
1	< 4 weeks	0	0
2	4 weeks – 6 weeks	1	3.70%
3	6 weeks – 3 months	13	48.14%
4	3 months – 6 months	11	40.74%
5	6 months – 1 year	2	7.40%
6	>1 year	0	0
	Total	27	100%

In tibial fracture cases, the average time taken for union ranged from 12 – 13 weeks. Union was delayed in cases with infection and in cases who have initially received external fixator . One of the case for which Ilizarov fixator was applied for uncontrolled infection had union at around 6 months and in one of the case for which Ilizarov ring fixator applied for infective non-union had bony union at around 8 – 9 months.

KNEE MOBILISATION:

Knee mobilisation was individualised and was started depending upon the fracture type and the implant used. The period of initialisation of knee mobilization ranged from 1 week to 12 weeks.

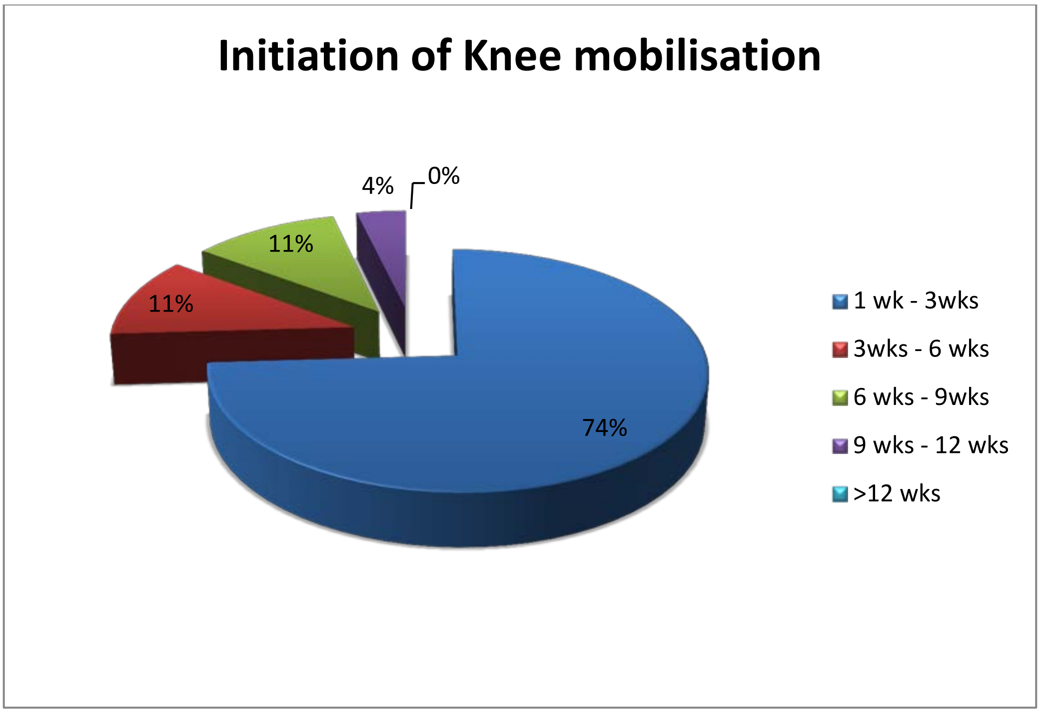


Chart no. 17

Twenty cases (74%) were initiated on knee mobilisation within three weeks of injury once definitive fixation has been done. In 3 of our case, knee mobilisation was started only after 3 weeks and in another three of our case knee mobilisation was initiated only after 6 weeks. In one of our case the mobilisation was initiated only after 9 weeks.

KNEE - RANGE OF MOVEMENTS :

The knee range of motion was an important criteria in the functional assessment after bony union . the maximum range recorded in our study ranged from 0 degree to 130 degrees. The minimum range recorded in our study ranged from 0 – 30 degrees. The average range of motion at knee joint in our of study of 27 patients ranged from 50 - 90 degrees .

CASE 1 – TYPE I FRASER INJURY RIGHT SIDE – CLOSED INJURY

FUNCTIONAL OUTCOME

TIBIA FIXATION- 2ND DAY; FEMUR- 5TH DAY

EXCELLENT FUNCTIONAL OUTCOME

CASE -2 TYPE II A FRASER INJURY LEFT SIDE – CLOSED INJURY

PRE-OP

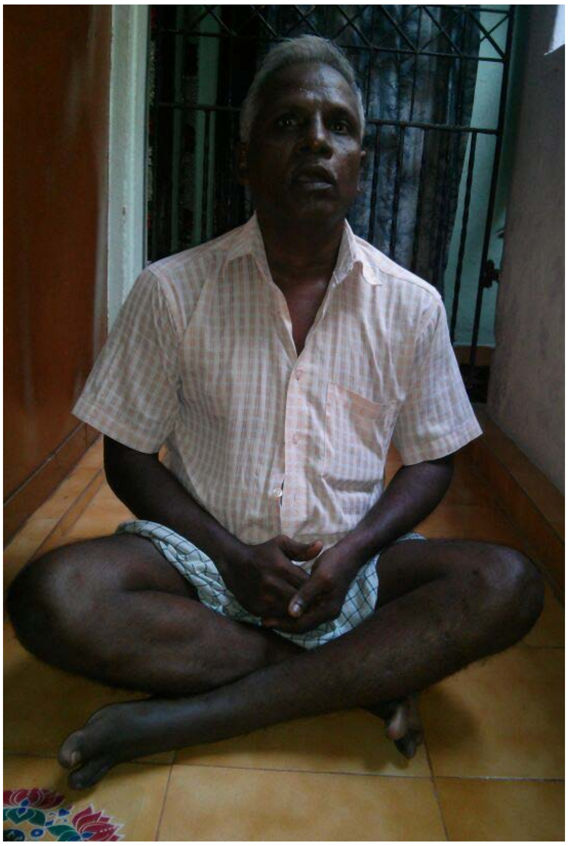
POST-OP

TIBIA FIXATION- 2ND DAY; FEMUR- 5TH DAY

4 MONTHS FOLLOW UP

ONE YEAR FOLLOW UP

FUNCTIONAL OUTCOME- EXCELLENT



CASE -3 TYPE II C FRASER INJURY RIGHT SIDE – CLOSED INJURY

PRE-OP

POST-OP- FEMUR FIXATION DONE ON 5TH DAY

POST-OP- TIBIA FIXATION DONE AFTER 3 WEEKS

6 MONTHS FOLLOW UP

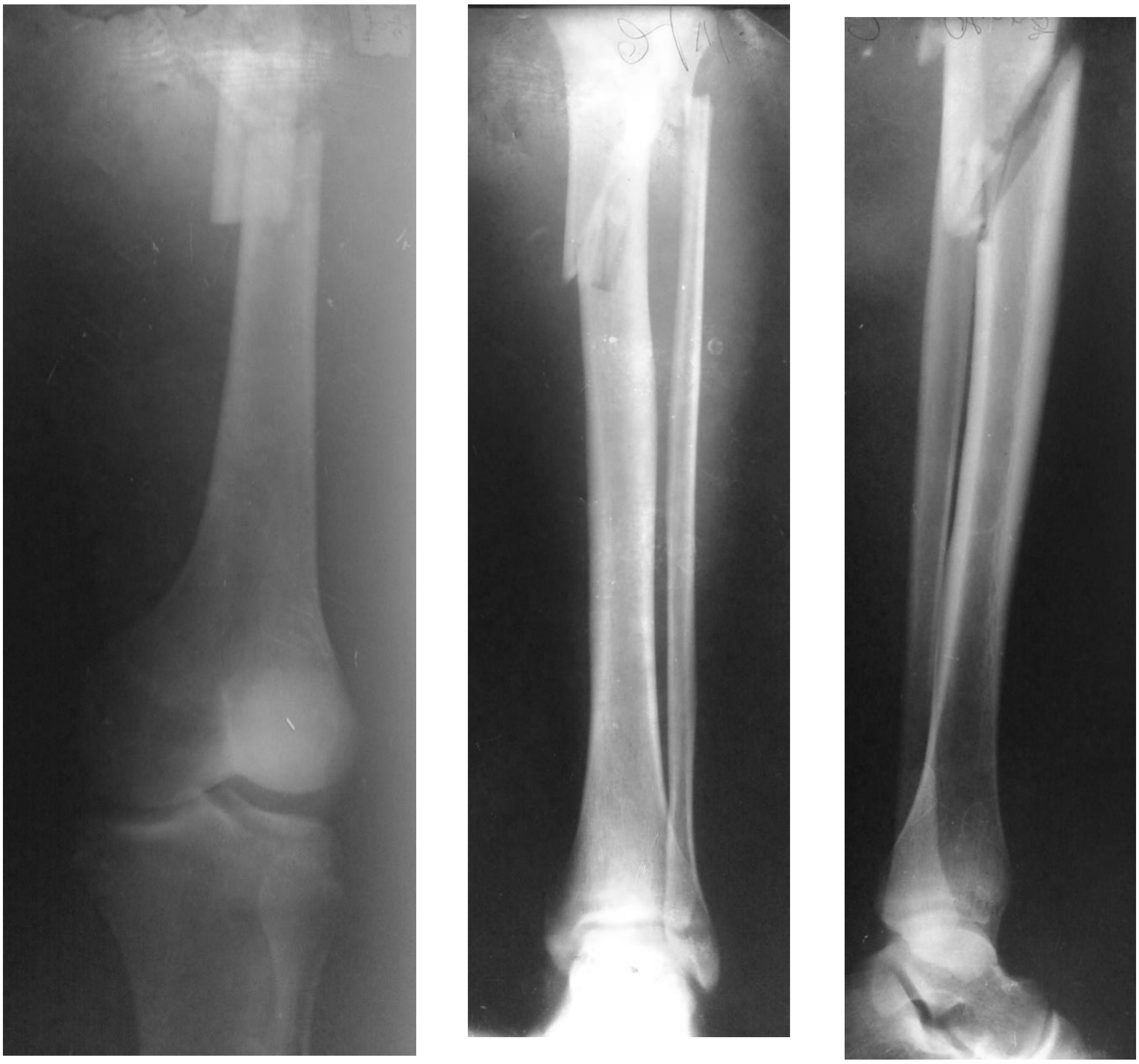
1 YEAR FOLLOW UP

FUNCTIONAL OUTCOME- POOR

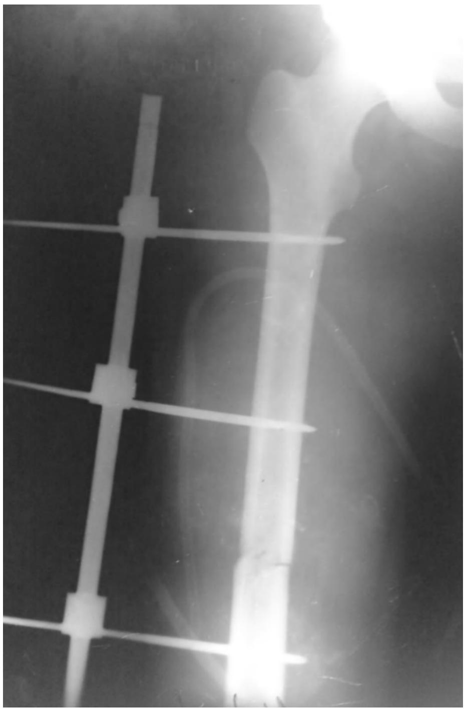
CASE -3 TYPE I FRASER INJURY LEFT SIDE

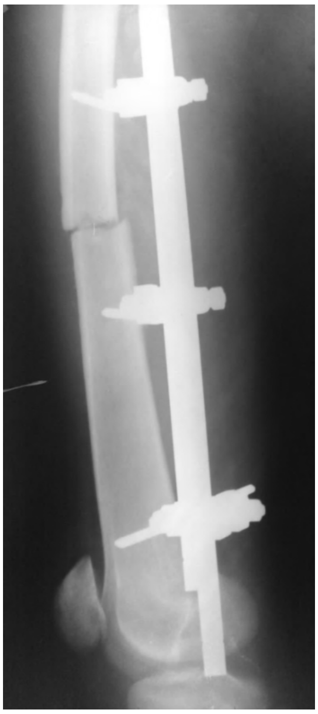
FEMUR- GRADE IIIA COMPOUND INJURY; TIBIA CLOSED

PRE-OP



EMERGENCY EX-FIX FOR FEMUR





OPEN TIBIA NAILING ON 5TH DAY

POST-OP COMPLICATION- INFECTION- TIBIAL SITE TREATED WITH ANTIBIOTICS

FEMORAL SIDE EX-FIX RETAINED, REMOVED AT 6 WEEKS 4MONTHS FOLLOW UP

FOLLOW UP- 1 YEAR- TIBIA NAIL REMOVED

FUNCTIONAL OUTCOME- POOR

Our study comprises of 27 cases of floating knee injuries and all the patients were managed according to the protocol as mentioned in the methodology. All the patients were assessed functionally after bony union using Karlstrom and Olerud criteria.

FUNCTIONAL OUTCOME MEASUREMENT:

Table no. 13. KARLSTROM AND OLERUD CRITERIA:

S.no	Outcome	No.of cases	Percentage
1	Excellent	5	18.52%
2	Good	8	29.63%
3	Acceptable	9	33.33%
4	Poor	5	18.52%
Total		27	100%

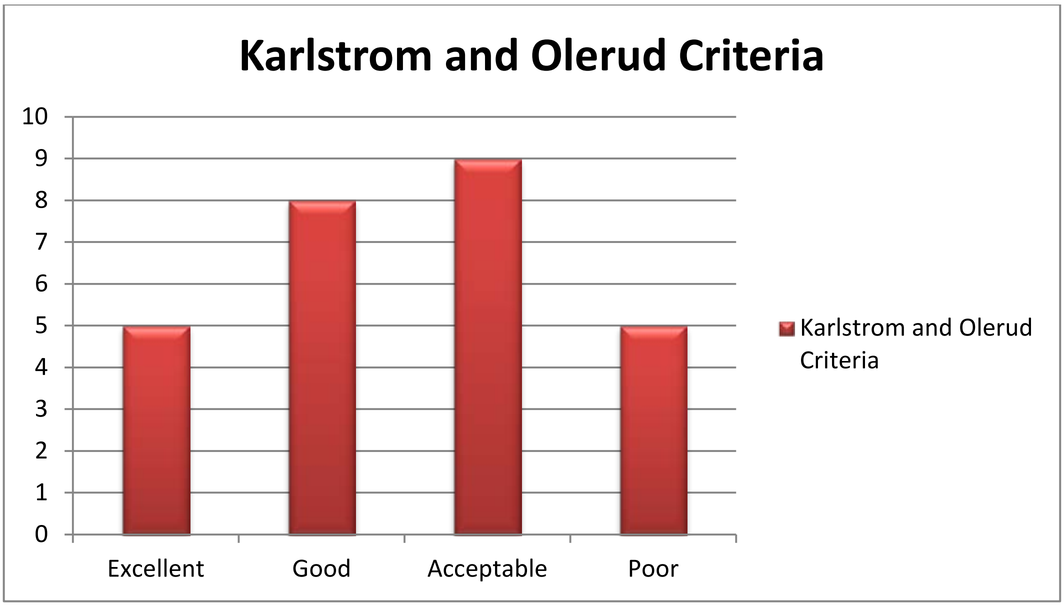


Chart no.18

EXCELLENT OUTCOME CATEGORY:

There were five patients (18.52%) with excellent outcome. Four patients had Type I Fraser injury and had both femur and tibia nailing done within a period of 1 week. One patient had Type II A Fraser injury and had femur nailing and tibia plating done for the fractures within 1 week of injury. All these patients were started on early mobilisation and weight bearing. None of these patients had infection. All these patients had no pain or any deformity. After an average period of 4 – 6 months, all these patients returned back to their pre-trauma works. The knee range of motion was from 0-130 degrees in two patients, 0 – 120 degrees in two patients and 0 – 115 degrees in one patient.

GOOD OUTCOME CATEGORY:

There were eight (29.63%%) patients with good outcome. Six of these patients belonged to Type I Fraser category and one of the patient belonged to Type II A Fraser category and one patient came under Type II B category of floating knee injuries. Six of the patients were managed with intramedullary nailing for both the fractures. One of the patient being managed with femur nailing and tibia plating and the other one with femur plating and tibia nailing. Mild infection which got settled by appropriate antibiotics was there in two of this category patients. Among this group , six patients experienced intermittent knee pain but not severe. These patients returned to their pre-trauma jobs after the accident. The knee range of motion ranged from 0 – 100 degrees in six patients , one patient had a range of 10 – 100 degrees , one patient 0 – 105 degrees.

ACCEPTABLE OUTCOME CATEGORY :

Acceptable outcome were seen in nine (33.3%) of our patients, out of these four patients had delayed union and two patients had infection. One of the patient with infection required implant removal to control the infection. There were two patients with shortening of about 1 to 2.5 cm . The average knee range of motion for these patients was 0 – 90 degrees. The walking distance of these patients were restricted. Five patients have severe symptoms impairing function and changed their pre-trauma jobs.

POOR OUTCOME CATEGORY:

Poor outcomes were seen in 5 (18.52%) patients out of 27 cases. 3 out of five patients had infection . one of the patient required conversion to Ilizarov fixator in the tibial side. Four of these patients had compound injuries and were managed with some form of external fixation initially. Two of these compound injuries belonged to Type II A Fraser category with tibial side compounding in one and both sides compounding in one. One patient comes under Type II C fracture with both tibial and femoral side compounding. Another patient had Type I fraser injury with femoral side compounding . The average range of motion of knee of these patients was 15 – 60 degrees . There was shortening of 1-2.5cm seen in two patients. 3 of these patients requires support in the form of crutch or other forms of walking aids. All these patients changed their pre-injury works.

COMPARISION WITH OTHER STUDY:

This study done in our institution was compared with some of the studies concerning Floating knee injuries and the outcomes compared between the studies as follows :

Table no.14. Comparision table with other studies :

Study	No.of patients	Excellent outcome	Good outcome	Acceptable outcome	Poor outcome
Fraser et al study 1978	63	3	15	30	15
Schiets et al study 1994	18	4	7	-	7
Hee et al study 2001	89	6	54	25	4
Anoop kumar et al study 2006	42	7	14	14	7
Ulfin Rethnam et al study 2007	29	15	9	2	3
Our study 2014	27	5	8	9	5

Earlier studies published prior to the year 2000 had so many poor outcome category. But later, the scenario changed as there was better understanding of the physiological response to trauma, management of associated injuries, concept of second hit and principles of Damage control Orthopaedics and internal fixation and their effect in the overall outcome. A recent study (2007) published by Rethnam et al shows that around 50% of cases had excellent outcome and only 10% of patients had poor functional outcome. They concluded by saying that treatment of associated injuries and rigorous post-operative rehabilitation were the key stones in achieving good functional outcome in these patients. We had around 47-50% of cases with excellent to good functional outcome and 18% of patients with poor functional outcome.

Conclusion

Conclusion:

Floating knee injuries are more complex injuries. In our study we found that most of the patients belonged to the working population ranging from 25 – 35 years and most of the patients were male patients.

Most of the injury pattern in our study belonged to Type I Fraser injury with both femoral and tibial side being shaft fractures. Type I Fraser injuries managed with intra-medullary nailing for both fractures tend to have better functional outcome and knee range of movements when compared to intra-articular fractures and compound injuries. Compound injuries and soft tissue injuries were common with these group of patients. Associated injuries were common in these group of patients. It may range from ipsilateral limb injury to life threatening other system injuries requiring early resuscitation.

Initial resuscitation based on ATLS protocol, selecting the correct timing of definitive fixation, understanding and knowledge regarding biochemical inflammatory markers help to minimize the second hit in these patients with extensive injury.

Intra-operative and post-operative complications are common with these group of patients which may range from infection to life threatening problems like ARDS/MODS.

The overall functional outcome of these patients depend upon so many factors like:

1) The type of fracture (open /closed)
2) Degree of comminution
3) Shaft /intra-articular fractures
4) Type of initial procedure
5) Timing of fixation of both the fractures
6) Timing of initiating knee mobilisation
7) Associated complications
8) Other associated injuries and their management.

Limitations:

Since this study is a short term analysis of the outcome, it requires a further long term follow up with a bigger sample size to study the influence of various factors in the final functional outcome and to detect the prognostic indicators for these complex injuries.

Bibliography

BIBLIOGRAPHY

1. Letts M, Vincent N, Gouw G. The "floating knee" in children. J Bone Joint Surg Br 1986 May;68(3):442-46.

2. Veith RG, Winquist RA, Hansen ST Jr. Ipsilateral fractures of the femur and tibia. A report of fifty-seven consecutive cases. J Bone Joint Surg Am 1984 Sep;66(7):991-1002

3. Robert W. Bucholz, James D. Heckman- Rockwood and Greens fractures in adults, Fifth edition 2001;1731-70,1801-38,1845- 1931.

4. Blake R, McBryde A Jr . The floating knee: Ipsilateral fractures of the tibia and femur.South Med J 1975 Jan;68(1):13-6.

5. Karlstrom G, Olerud S . Ipsilateral fracture of the femur and tibia. J Bone Joint Surg Am 1977 Mar;59(2):240-43.

6. Fraser RD, Hunter GA, Waddell JP. Ipsilateral fracture of the femur and tibia. J Bone Joint Surg Br 1978 Nov;60-B(4):510-15.

7. Winston ME . The results of conservative treatment of fractures of the femur and tibia in the same limb. Surg Gynecol Obstet 1972 Jun;134(6):985-91

8. DeLee JC. Ipsilateral fracture of the femur and tibia treated in a quadrilateral cast brace. Clin Orthop Relat Res 1979 Jul-Aug;(142):115-22

9. Bansal VP, Singhal V, Mam MK, Gill SS The floating knee. 40 cases of ipsilateral fractures of the femur and the tibia. Int Orthop 1984;8(3):183-87.

10. Katada S, Ando K, Nakagawa K, Yamada T, Sasamoto H, Kawabe N et al. Floating knee fracture (ipsilateral fracture of the femur and tibia)--treatment by closed Ender nailing. Nippon Seikeigeka Gakkai Zasshi 1984 May;58(5):475-83.

11. Behr JT, Apel DM, Pinzur MS, Dobozi WR, Behr MJ. Flexible Intramedullary nails for ipsilateral femoral and tibial fractures. J Trauma 1987 Dec;27(12):1354- 57.

12. Gregory P, DiCicco J, Karpik K, DiPasquale T, Herscovici D, Sanders R . Ipsilateral fractures of the femur and tibia: treatment with retrograde femoral nailing and unreamed tibial nailing. J Orthop Trauma 1996;10(5):309-16.

13. Lobenhoffer P, Krettek C, Tscherne H. [Complex knee joint trauma] Orthopade. 1997 Dec;26(12):1037-45.

14. Ostrum RF . Treatment of floating knee injuries through a single percutaneous approach. Clin Orthop Relat Res. 2000 Jun;375:43-50.

15. Rethnam U . Single incision nailing of the floating knee-do we ignore the knee ligaments?. Int Orthop 2006 Aug;30(4):311.

16. Van Raay JJ, Raaymakers EL, Dupree HW . Knee ligament injuries combined with ipsilateral tibial and femoral diaphyseal fractures: the "floating knee". Arch Orthop Trauma Surg 1991;110(2):75-7.

17. Rethnam U, Yesupalan RS, and Nair R. The floating knee: epidemiology, prognostic indicators and outcome following surgical management. J trauma manage outcomes 2007;1-8.

18. Lundy DW, Johnson KD . "Floating knee" injuries: ipsilateral fractures of the femur and tibia. J Am Acad Orthop Surg 2001 Jul-Aug;9(4):238-45.

19. Theodoratos G, Papanikolaou A, Apergis E, Maris J: simultaneous ipsilateral diaphyseal fractures of the femur and tibia: treatment and complications. Injury 2001;32(4):313-15. 109

20. Rios JA, Ho-Fung V, Ramirez N, Hernandez RA. Floating knee injuries treated with single incision technique versus traditional antegrade femur fixation; A comparative study. Am J Orthop 2004 Sep;33(9):468-72.

21. Szalay MJ, Hosking OR, Annear P. Injury of knee ligament associated with ipsilateral femoral shaft fractures and with ipsilateral femoral and tibial shaft fractures. Injury 1990 Nov; 21 (6): 398-400.

22. Paul GR, Sawka MW, Whitelow GP. Fractures of ipsilateral femur and tibia, emphasis on intraarticular and soft tissue injury. J Orthop Trauma 1990;4(3): 309- 14.

23. Hung SH, Lu YM, Huang HT, Lin YK, Chang JK, Chen JC et al. Surgical treatment of type II floating knee: Comparison of the results of type IIA and type IIB floating knee. Knee Surg Sports Traumatol Arthroc 2007 May;15(5):578-86.

24. Yokoyama K, Tsukamoto T, Aoki S, Wakita R, Uchino M, Noumi T et al. Evaluation of functional outcome of the floating knee injury using multivariate analysis. Arch Orthop Trauma Surg 2002 Nov;122(8):432-35.

25. Hee HT, Wong HP, Low YP, Myers L. Predictors of outcome of floating knee injuries in adults: 89 patients followed for 2-12 years. Acta Orthop Scand 2001 Aug;72(4):385-94.

26. Elmrini A, Elibrahimi A, Agoumi O, Boutayeb F, Mahfoud M, Elbardouni A, et al. Ipsilateral fractures of tibia and femur or floating knee. Int Orthop 2006 Oct;30(5):325-28.

27. Ratliff AH. Fractures of the shaft of the femur and tibia in the same limb. Pro Roy Soc Med 1968;61:907-08.

28. Hojer H, Gillquist J, Liljedahl SO. Combined fractures of the femoral and tibial shafts in the same limb. Injury 1977;8:206-12.

29. Bo Rooser, Per Hansson. External fixation of ipsilateral fracture of the femur and tibia. Injury 1985 May;16(6):371-73.

30. Della Rocca GJ, Crist BD. External fixation versus conversion to intramedullary nailing for definitive management of closed fractures of the femoral and tibial shaft. J Am Acad Orthop Surg 2006;14(10):131-35

31. Anoop Kumar, Mam MK, Rajesh Paul. Ipsilateral fracture of femur and tibia, treatment and functional outcome. J K Science: Journal of Medical Education and Research 2006;8 (1):42-44.

32. Anastopoulos G, Assimakopoulos A, Exarchou E, Pantazopoulos Th. Ipsilateral fractures of the femur and tibia. Injury 1992;23 (7):439-41.

33. Kao FC, Tu YK, Hsu KY, Su JY, Yen CY, Chou MC. Floating knee injuries: a high complication rate. Orthopedics Jan 2010;33(1):14

34. Schiedts D, Mukisi M, Bouger D, Bastaraud H . Ipsilateral fractures of the femoral and tibial diaphyses. Rev Chir Orthop Reparatrice Appar Mot 1996; 82(6):535-40.

35. Arslan H, Kapukaya A, Kesemenli CC, Necmioglu S, Subasi M, Coban V. The floating knee in adults: twenty-four cases of ipsilateral fractures of the femur and the tibia. Acta Orthop Traumatol Turc 2003;37(2):107-12.

36. Mark P, Mc Andrew, William Pontorelli. The long term follow up of ipsilateral tibial and femoral diaphyseal fractures. Iowa Orthop J 1986;6:114-20

37. Fracture and dislocation compendium. Orthopaedic Trauma Association Committee for Coding and Classification. J Orthop Trauma 1996;(10):1-154

38. Schatzker J, McBroom R, Bruce D. The tibial plateau fracture. The Toronto experience 1968--1975. Clin Orthop Relat Res 1979;(138):94-104

39. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. J Bone Joint Surg Am 1976 Jun;58(4):453-58.

40. Gurd AR, Wilson RE. The Fat embolism syndrome. J Bone Joint Surg Br 1974;56:408–16.

41. Hayes JT: Multiple fractures in same extremity: Some problems in their management. Surgical Clinics of North America 1961;41:1379-88.

42. Adamson GJ, Wiss DA, Lowery GL, Peters CL. Type II floating knee: ipsilateral femoral and tibial fractures with intraarticular extension into the knee joint. J Orthop Trauma 1992;6(3):333-39.

43. Ul-Haque I. A floating knee treated conservatively: a case report. Injury 1983 May;14(6):554-57.

44. Dwyer AJ, Paul R, Mam MK, Kumar A, Gosselin RA. Floating knee injuries: long-term results of four treatment methods. Int Orthop 2005 Oct; 29(5):314-18.

Annexure

ANNEXURE – I - PROFORMA

Short term functional outcome analysis following fixation for floating knee injuries

Patient's Name :

Age:

Sex:

Occupation:

Address:

Contact no:

I.P.No:

Date of Injury:

Mode of Injury:

Date of admission:

Investigations : Complete haemogram,
Blood urea, sugar, Sr. Creatinine, Sr. lactate level
Bleeding time and clotting time
ECG
Chest X-ray
Plain X-ray AP and Lateral view of the affected limb

Type of fracture – femur (open /closed)

Type of fracture - tibia (open/closed)

Type of fracture- femur (intra/extra articular)

Type of fracture – tibia (intra/extra articular)

Diagnosis: (using modified Fraser classification)

Type of Initial procedure: Femur-

Tibia –

Order of fixation-

Date of First definitive fixation :

Date of second definitive fixation:

Associated injuries:

Treatment given for associated injuries:

Time delay for first definitive fixation:

Time delay between two definitive fixations:

Implants used:

Intra operative complications:

Post operative complications :

Treatment given for post-operative complication:

Post operative knee mobilisation started at :

Follow up: evaluated with AP and Lateral plain radiographs for evidence of bony union at

Immediate post op
4 weeks post op
8 weeks post op
3 months post op
6 months post op
1 year post op

Functional assessment using Karlstrom criteria:
Excellent
Good
Acceptable
Poor

ANNEXURE – 2 –KARLSTROM AND OLERUD CRITERIA

criterion (symptoms)		excellent	good	acceptable	poor
subjective	thigh and leg	0	mild, intermittent	severe, restrains function	pain at rest
	knee and ankle	0	idem	Idem	idem
Gait		normal	idem	limited distance	use of supports
work and sports		pre-injury level	normal work sport restraint	changed work	permanent disability
angular and rotational displacement		0	< 10°	10 - 20°	> 20°
Shortening		0	< 1cm	1 - 3cm	> 3cm
ROM restraint	ankle	0	< 10°	10° - 20°	> 20°
	hip and knee	0	< 20°	20° - 40°	> 40°

Idem – same as above

ANNEXURE – 3 -PATIENT CONSENT FORM

SHORT TERM FUNCTIONAL OUTCOME ANALYSIS FOLLOWING FIXATION FOR FLOATING KNEE INJURIES

STUDY DETAIL: PROSPECTIVE DESIGN

STUDY CENTRE: GOVT.ROYAPETTAH HOSPITAL,CHENNAI

PATIENT'S NAME, AGE, SEX:

DATE & PLACE:

IDENTIFICATION NUMBER:

I confirm that I have understood the purpose and procedure of the above study. I have the opportunity to ask questions and all my questions and doubts have been answered to my complete satisfaction.

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected.

I understand that the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However I understand that my identity would not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study.

I hereby consent to participate in this study.

I have been clearly explained about the ATLS protocol and Damage control Orthopaedics which may be applied as required.

I hereby give permission to undergo complete clinical examination and diagnostic tests including haematological, radiological tests and to undergo the surgical procedure which is individualised based on the fracture pattern.

Patient's name with signature/Lt thumb impression

ANNEXURE – 4 - **நோயாளி ஒப்புதல் படிவம்**

ஆராய்ச்சியின் விவரம்: SHORT TERM FUNCTIONAL OUTCOME ANALYSIS FOLLOWING FIXATION FOR FLOATING KNEE INJURIES

ஆராய்ச்சி மையம்:

நோயாளியின் பெயர்: நோயாளியின் வயது:

பதிவு எண்:

நோயாளி கீழ்கண்டவற்றுள் கட்டங்களை (✓) செய்யவும்

1. மேற்குறிப்பிட்டுள்ள ஆராய்ச்சியின் நோக்கத்தையும் பயனையும் முழுவதுமாக புரிந்துகொண்டேன். மேலும் எனது அனைத்து சந்தேகங்களையும் கேட்டு அதற்கான விளக்கங்களையும் தெளிவுபடுத்திக் கொண்டேன். ☐

2. மேலும் இந்த ஆராய்ச்சிக்கு எனது சொந்த விருப்பத்தின் பேரில் பங்கேற்கிறேன் என்றும், மேலும் எந்த நேரத்திலும் எவ்வித முன்னறிவிப்புமின்றி இந்த ஆராய்ச்சியிலிருந்து விலக முழுமையான உரிமை உள்ளதையும், இதற்கு எவ்வித சட்ட பிணைப்பும் இல்லை என்பதையும் அறிவேன். ☐

3. ஆராய்ச்சியாளரோ, ஆராய்ச்சி உதவியாளரோ, ஆராய்ச்சி உபயத்தாரோ, ஆராய்ச்சி பேராசிரியரோ, ஒழுங்குநெறி செயற்குழு உறுப்பினர்களோ எப்போது வேண்டுமானாலும் எனது அனுமதியின்றி எனது உள்நோயாளி பதிவுகளை இந்த ஆராய்ச்சிக்காகவோ அல்லது எதிர்கால பிற ஆராய்ச்சிகளுக்காகவோ பயன்படுத்திக்கொள்ளலாம் என்றும், மேலும் இந்த நிபந்தனை நான் இவ்வாரய்ச்சியிலிருந்து விலகினாலும் தகும் என்றும் ஒப்புக்கொள்கிறேன். ஆயினும் எனது அடையாளம் சம்பந்தப்பட்ட எந்த பதிவுகளும் (சட்டபூர்வமான தேவைகள் தவிர) வெளியிடப்படமாட்டாது என்ற உறுதிமொழியின் பெயரில் இந்த ஆராய்ச்சியிலிருந்து கிடைக்கப்பெறும் முடிவுகளை வெளியிட மறுப்பு தெறிவிக்கமாட்டேன் என்று உறுதியளிக்கின்றேன். ☐

4. இந்த ஆராய்ச்சிக்கு நான் முழுமனதுடன் சம்மதிக்கின்றேன் என்றும் மேலும் ஆராய்ச்சிக் குழுவினர் எனக்கு அளிக்கும் அறிவுரைகளை தவறாது பின்பற்றுவேன் என்றும் இந்த ஆராய்ச்சி காலம் முழுவதும் எனது உடல் நிலையில் ஏதேனும் மாற்றமோ அல்லது எதிர்பாராத பாதகமான விளைவோ எற்படுமாயின் உடனடியாக ஆராய்ச்சி குழுவினரை அணுகுவேன் என்றும் உறுதியளிக்கின்றேன். ☐

5. இந்த ஆராய்ச்சிக்குத் தேவைப்படும் அனைத்து மருத்துவப் பரிசோதனைகளுக்கும் ஒத்துழைப்பு தருவேன் என்று உறுதியளிக்கின்றேன். ☐

6. இந்த ஆராய்ச்சிக்கு யாருடைய வற்புருத்தலுமின்றி எனது சொந்த விருப்பத்தின் பேரிலும் சுயஅறிவுடனும் முழுமனதுடனும் சம்மத்திக்கின்றேன் என்று இதன் மூலம் ஒப்புக்கொள்கிறேன். ☐

நோயாளியின் கையொப்பம் / பெருவிரல் கைரேகை ஆராய்ச்சியாளரின் கையொப்பம்

இடம்: தேதி:

INSTITUTIONAL ETHICAL COMMITTEE
GOVT.KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Ref.No.5098/ME-1/Ethics/2014 Dt:10.07.2014.
CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "A short term functional outcome analysis following fixation for floating knee injuries" - For Project work submitted by Dr.Poorana Raja.T, MS (Ortho), PG Student, KMC, Chennai-10.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

8/8/14

GOVT. KILPAUK MEDICAL COLLEGE
8 AUG 2014
Kilpauk, Chennai-10.

CHAIRMAN,
Ethical Committee
Govt.Kilpauk Medical College,Chennai

8/8/2014

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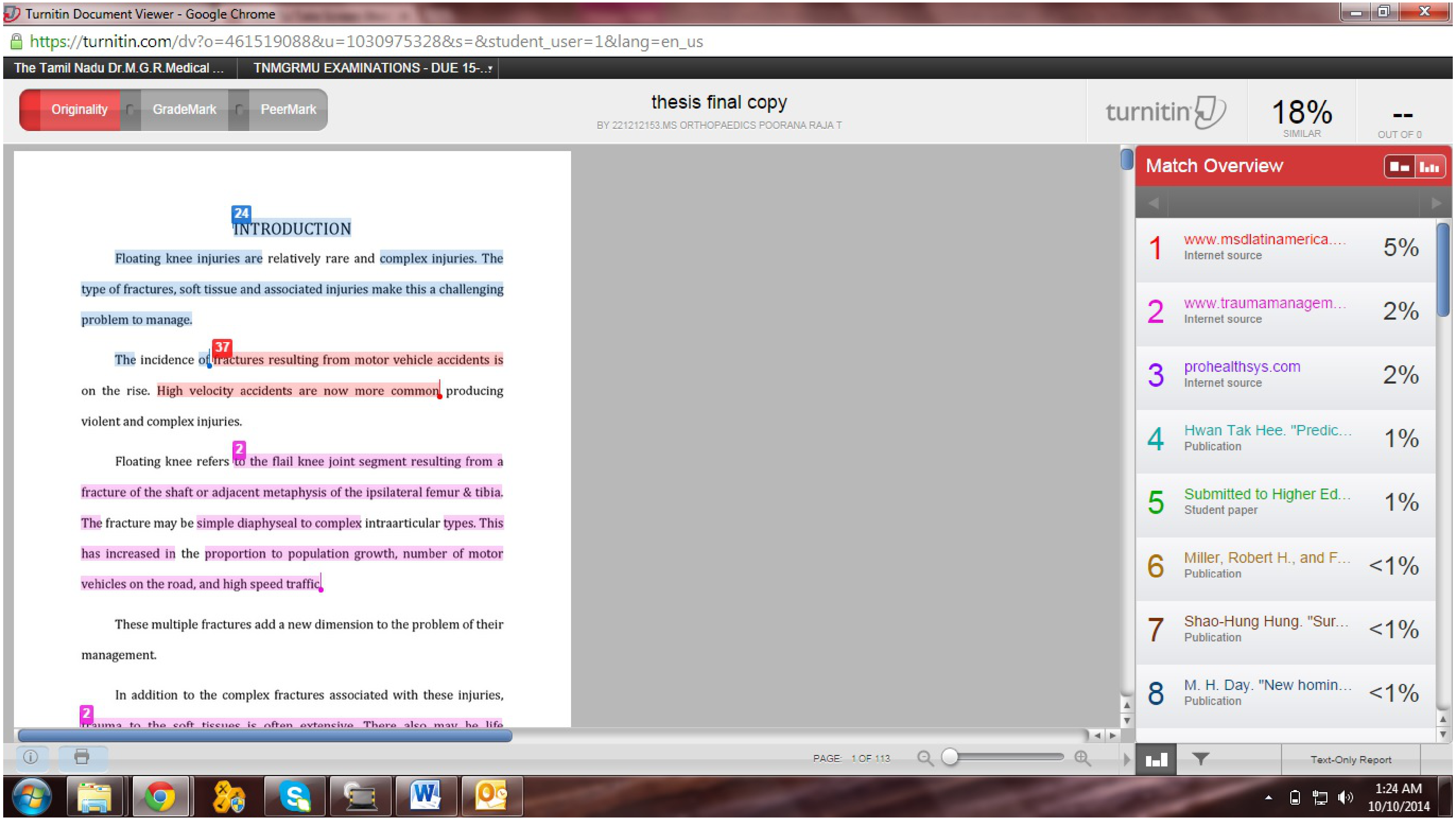
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INTRODUCTION
Floating knee injuries are relatively rare and complex injuries. The type of fractures, soft tissue and associated injuries make this a challenging problem to manage.
The incidence of fractures resulting from motor vehicle accidents is on the rise. High velocity accidents are now more common producing violent and complex injuries.
Floating knee refers to the flail knee joint segment resulting from a fracture of the shaft or adjacent metaphysis of the ipsilateral femur & tibia. The fracture may be simple diaphyseal to complex intraarticular types. This has increased in the proportion to population growth, number of motor vehicles on the road, and high speed traffic.
These multiple fractures add a new dimension to the problem of their management.
In addition to the complex fractures associated with these injuries,
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10/10/2014

MASTER CHART

SERIAL NO.	AGE	SEX	SIDE	MECHANISM OF INJURY	TYPE OF FRACTURE- FEMUR- OPEN/CLOSED	TYPE OF FRACTURE- FEMUR- INTRA/EXTRA-ARTICULAR	TYPE OF FRACTURE- TIBIA- OPEN /CLOSED	TYPE OF FRACTURE- TIBIA- INTRA/EXTRA ARTICULAR	FRASER CLASSIFICATION	ASSOCIATED INJURIES	ADDITIONAL PROCEDURES BEFORE DEFINITIVE FIXATION	TYPE OF DEFINITIVE FIXATION- FEMUR	TYPE OF DEFINITIVE FIXATION- TIBIA	ORDER OF FIXATION	BONY UNION-FEMUR	BONY UNION- TIBIA	FUNCTIONAL OUTCOME	DIC	FAT EMBOLISM	POST-OP INFECTION	IMPLANT FAILURE	DELAYED UNION	MALUNION	NON-UNION	NERVE INJURY	WOUND DEBRIDEMENT	WOUND COVERAGE	EXCHANGE OF IMPLANT	IMPLANT REMOVAL	BONE GRAFTING	KNEE- RANGE OF MOVEMENTS
1	32	1	1	1	1	1	1	1	1	2	2	1	1	2	12	13	1	1	1	1	1	1	1	1	1	1	1	1	2	1	0-130
2	33	1	2	2	2	1	1	1	1	1	1	3	1	2	16	14	4	1	1	2	1	1	1	1	1	2	1	1	2	1	0-60
3	22	1	1	1	1	1	2	1	1	1	1	1	1	1	12	11	2	1	1	1	1	1	1	1	1	2	1	1	1	1	0-100
4	38	1	1	2	1	1	2	1	1	2	1	1	1	3	11	12	2	1	1	1	1	1	1	1	1	2	1	1	1	1	0-100
5	28	1	1	1	1	1	2	1	1	1	1	1	1	1	35	16	3	1	1	2	1	2	1	1	1	2	1	1	1	2	0-100
6	36	1	2	4	1	1	2	1	1	1	1	1	1	1	12	28	3	1	1	1	1	2	1	1	1	2	1	1	1	1	10-90
7	25	1	1	1	1	1	2	1	1	1	1	1	1	2	36	12	3	1	1	2	1	2	1	1	1	2	1	2	1	1	0-80
8	39	1	1	3	1	1	2	1	1	2	1	1	1	1	13	40	3	1	1	2	1	1	1	2	1	2	2	2	1	1	0-105
9	32	1	2	1	1	1	2	1	1	2	1	1	1	1	12	12	2	1	1	1	1	1	1	1	1	2	1	1	1	1	0-100
10	26	1	1	1	1	1	2	1	1	2	1	1	1	1	13	13	2	1	1	1	1	1	1	1	1	2	1	1	1	1	0-100
11	53	1	2	2	1	1	1	1	1	2	2	1	1	2	11	13	3	1	1	1	1	1	1	1	1	1	1	1	1	1	0-90
12	33	2	1	1	1	1	1	1	1	1	2	1	1	2	8	15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0-130
13	45	1	1	2	1	1	1	1	1	2	2	1	1	2	9	8	2	1	1	1	1	1	1	1	1	1	1	1	1	1	0-105
14	43	2	1	2	1	1	1	1	1	1	2	1	1	2	8	6	2	1	1	1	1	1	1	1	1	1	1	1	1	1	0-100
15	40	1	2	3	1	1	1	1	1	2	2	1	1	2	12	7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0-120
16	40	1	1	1	1	1	1	1	1	1	2	1	1	2	15	8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0-120
17	27	1	1	3	1	1	1	1	1	2	2	1	1	2	13	9	4	1	1	1	1	1	1	1	1	1	1	1	1	1	0-45
18	30	1	1	1	2	1	2	2	2	2	1	1	2	3	16	14	2	1	1	2	1	1	1	1	1	2	1	1	1	1	10-100
19	38	1	1	2	1	1	2	2	2	1	1	1	2	3	15	12	4	1	1	2	1	1	1	1	1	2	2	1	1	1	10-50
20	38	2	1	2	2	1	1	2	2	2	2	1	2	2	9	9	2	1	1	1	1	1	1	1	1	1	1	1	1	1	0-100
21	36	1	2	1	1	1	1	2	2	1	2	1	2	2	12	24	1	1	1	1	1	2	1	1	1	1	1	1	1	1	0-115
22	23	1	1	1	2	2	1	1	3	1	1	2	1	1	30	9	3	1	1	1	1	2	2	1	1	2	1	1	1	2	0-80
23	35	1	2	4	1	2	1	1	3	2	2	2	1	1	15	14	3	1	1	1	1	1	1	1	1	1	1	1	1	1	0-95
24	46	1	1	4	2	2	2	2	4	2	1	2	2	3	18	13	4	1	1	2	1	1	2	1	1	2	2	1	1	1	0-70
25	23	1	1	4	1	2	1	2	4	2	2	2	2	3	13	11	3	1	1	1	1	1	2	1	1	1	1	1	1	1	5-100
26	42	1	2	1	1	2	1	2	4	2	2	2	2	3	14	12	3	1	1	1	1	1	1	1	1	1	1	1	1	1	0-90
27	37	1	1	2	1	2	1	2	4	1	2	2	2	1	12	12	4	1	1	1	1	1	1	1	1	1	1	1	1	1	0-70

KEY TO MASTER CHART

SEX: Male (1), Female (2)

SIDE: Right (1), Left(2)

MODE OF INJURY: Four wheeler accident (1)

Two wheeler accident (2)

Fall from height (3)

Pedestrian injury (4)

TYPE OF FRACTURE –FEMUR: Closed (1), Open(2)

FEMUR-INTRA/EXTRA-ARTICULAR: Intra (1), Extra articular(2)

TYPE OF FRACTURE-TIBIA: Closed (1), Open(2)

TIBIA-INTRA/EXTRA-ARTICULAR: Intra (1), Extra articular(2)

FRASER CLASSIFICATION:

Type I (1)

Type IIA (2)

Type IIB (3)

Type IIC (4)

ASSOCIATED INJURIES: No(1), Yes(2)

ADDITIONAL PROCEDURES BEFORE DEFINITIVE FIXATION: Yes(1), No(2)

DEFINITIVE FIXATION –FEMUR:

Nailing (1)

Plating (2)

Exfix (3)

Others (4)

DEFINITIVE FIXATION – TIBIA:

Nailing (1)

Plating (2)

Exfix (3)

Others (4)

ORDER OF FIXATION:

Femur then tibia (1)

Tibia then femur (2)

Same stage femur and tibia (3)

BONY UNION - FEMUR: in weeks

BONY UNION – TIBIA: in weeks

DIC: No(1), Yes(2)

FAT EMBOLISM: No (1), Yes(2)

INFECTION: No (1), Yes(2)

IMPLANT FAILURE: No(1), Yes(2)

DELAYED UNION: No(1), Yes(2)

MAL-UNION: No(1), Yes(2)

NON-UNION: No(1), Yes(2)

NERVE INJURY: No(1), Yes(2)

WOUND DEBRIDEMENT: No(1), Yes(2)

WOUND COVERAGE: No(1), Yes(2)

EXCHANGE OF IMPLANT: No(1), Yes(2)

IMPLANT REMOVAL: No(1), Yes(2)

BONE GRAFTING: No(1), Yes(2)

KNEE RANGE OF MOVEMENTS : in degrees.